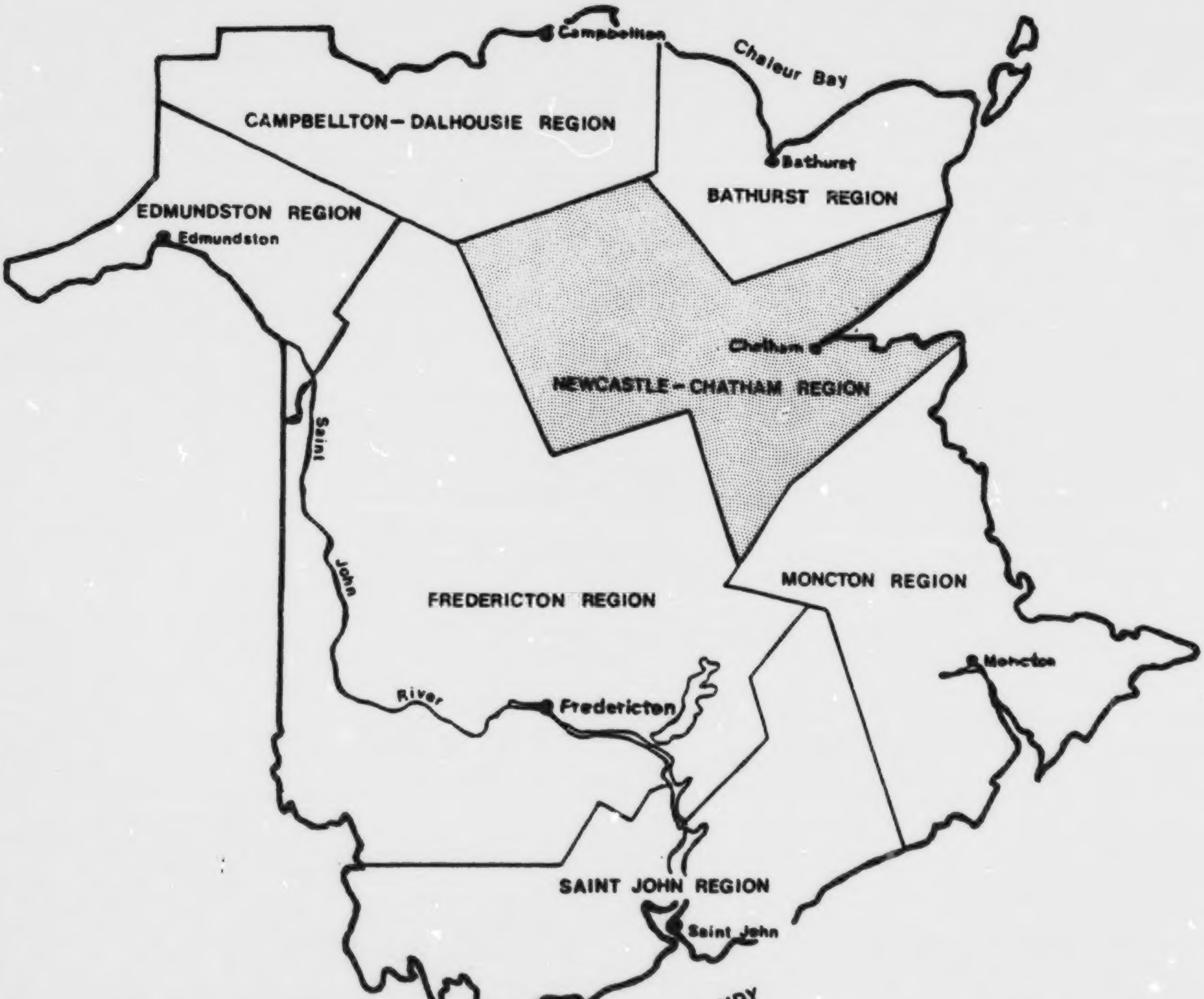
NEW BRUNSWICK
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

REPORT I-8401

NEWCASTLE – CHATHAM PLANNING REGION WATER RESOURCES REVIEW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DECEMBER, 1984

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WATER RESOURCES REVIEW

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W. Franklin G. Cardy, Director

NEW BRUNSWICK DEPARTMENT OF THE ENVIRONMENT

Hon. C.W. Harmer, Minister   B.B. Barnes, Deputy Minister

PREFACE

This is the sixth in a series of seven water resources review reports covering the entire Province of New Brunswick. These reports summarize the state of knowledge concerning the available water resources in each of the seven planning regions. They also identify existing and predicted constraints on the exploitation of the water resource and outline planning and management measures that may be taken to ensure continued resource availability for future use.

This report is devoted to the Newcastle-Chatham Planning Region which is located in east central New Brunswick and includes most of the County of Northumberland.

The contents of the report are presented as follows:

Chapter One provides a general introduction to the planning region with regard to its history, population, climate and physiographic and geologic conditions.

Chapter Two deals with the water resources of the region. The planning region is divided into four different sub-areas and the water availability and use in each of these sub-areas is discussed.

Chapter Three covers specific water requirements and supplies for each of the eight incorporated municipalities within the planning region. Resource data are presented in a summarized format for use as a ready reference by those requiring information on the water resources of the region.

Factors related to the management of the water resource are discussed in Chapter Four. This chapter emphasizes the need for careful operation, maintenance, and protection of the public water supplies.

The Appendices provide specific information on the Newcastle-Chatham Planning Region. This information includes lists of hydrometric, climatological and water quality stations in the region as well as flow duration and lowflow analysis of the available historical data. A physical description of watercourses in the region is also presented here.

SUMMARY

This review of the water resources in the Newcastle-Chatham Planning Region highlights the fact that although most of the municipalities are situated along the Miramichi River and its main tributaries, the majority of the municipalities within the region depend on groundwater for their water supply.

Despite this, there is a lack of comprehensive information on the groundwater resource. Numerous groundwater investigations have taken place in the region and there is a wealth of knowledge among local well drillers but this report is the first in which an effort has been made to bring this information together and make it available.

Recently, large sums of money have been spent for the investigation and development of public water supplies in the Town of Chatham and other municipalities in this Planning Region. These investigations were initiated to upgrade the supplies in the municipalities with funding assistance from the General Development agreement.

The major concern now is to ensure that the water systems are operated with care and their performance monitored. Monitoring the pumping levels in production wells and performing leakage testing the water supply systems are important for evaluating the performance of these systems. Such programs will aid in the assessment of the daily per capita consumption which appears to be above the provincial average in several municipalities within the planning region.

The water quality in the Newcastle-Chatham Region is generally good. However, groundwater supplies located in the deeper river basin alluvial deposits tend to have elevated manganese content. This may lead to aesthetic quality problems, such as staining of fixtures and laundry,but is not a health concern.

Overpumping, diminishing well yields and deteriorating water quality due to increasing chloride and manganese concentration continue to be problems for groundwater users in the Chatham area.

RECOMMENDATIONS

The following recommendations have resulted from this review of the water resources in the Newcastle-Chatham Planning Region.

1. A groundwater monitoring program should be established in order to overcome the lack of information on the groundwater sources. Such a program would provide information which is necessary for the management and planning of the resource. It would also provide for identification and evaluation of potential aquifers. The data obtained from such a program is essential in evaluating the security of the groundwater resources from the quantity and quality points of view.

2. Periodic reviews of demand projections in relation to the available water resources should be made. Such reviews are essential tools for planning purposes. The time frame of these reviews would depend on the residential and/or industrial developments in each individual incorporated area.

3. All municipalities should keep daily records of their pumping rate as well as water level measurements in the production wells. Such records are necessary in evaluating the performance of the source and also in assessing the consumption rate within each municipality.

4. Development in areas surrounding groundwater sources, production wells and groundwater recharge areas should be planned so that the danger of spills of petroleum products or repeated unintentional applications of waste products or chemicals is limited as much as possible.

5. Development in watersheds and recharge areas used for public water supply sources should be very carefully considered to ensure that the quality of the sources is maintained. In the long run, development of the land must be carried out with the water resource in mind. Conversely, management of the water resources alone is ineffective without appropriate use of the land resource.

6. Municipalities should encourage their water works operators to attend training courses offered in their field. Such courses are designed, among other things, to familiarize the operators with the importance of thorough monitoring of their water supply systems.

7. Early communication and consultation should be established between municipalities or industries seeking new water supplies and the Water Resources Branch. Reference should be made to "The Guidelines for Approval of Water Supply Sources" available from the Water Resources Branch, New Brunswick Department of the Environment. Such an approach will result in better management of the resource and help to ensure the maintenance of adequate quantity and quality of water for all users within the region.

ACKNOWLEDGEMENTS

This report was prepared by the Water Resources Branch, New Brunswick Department of the Environment, under the direction of Mr. Franklin Cardy. The text was written by M.E. Folster and edited by Dr. Nabil Elhadi.

We also wish to thank those other agencies, municipalities and individuals who provided information for this report and who assisted in various ways with the preparation. Prominent among these were the Mayors of all incorporated municipalities within the Newcastle-Chatham Planning Region, the Pollution Control and Environmental Services Branches of the Department of the Environment as well as the Deputy Minister, Brian Barnes and the staff of the Water Resources Branch, especially Mrs. Denice Poirier who typed the report.

TABLE OF CONTENTS

PAGE

PREFACE. i
SUMMARY. ii
RECOMMENDATIONS. iii
ACKNOWLEDGEMENTS v
TABLE OF CONTENTS. vi
LIST OF FIGURES. viii
LIST OF TABLES ix

CHAPTER

1. THE REGION 1
  1.1 Introduction. 2
  1.2 History 5
    1.2.1 Pre-confederation Period 5
    1.2.2 Confederation Period 7
  1.3 Population and Housing Characteristics. 10
  1.4 Climate 16
  1.5 Physiography and Geology 21

2. THE WATER RESOURCE 26
  2.1 Regional Review by Area 27
    2.1.1 Preamble 27
    2.1.2 Water Availability 29
      2.1.2.1 Response of Well Water Levels to Earthquakes, Winter, 1982. 38
    2.1.3 Water Quality. 41
      2.1.3.1 Surface Water Quality 41
      2.1.3.2 Ground Water Quality. 50
  2.2 The Upper Nepisiquit Area 53
    2.2.1 General Discussion-Upper Nepisiquit Area 53
    2.2.2 Water Use-Upper Nepisiquit Area. 57
  2.3 The Northwest Miramichi Area. 58
    2.3.1 General Discussion-Northwest Miramichi Area 58
    2.3.2 Water Use-Northwest Miramichi Area 62
  2.4 The Little Southwest Miramichi Area 63
    2.4.1 General Discussion-Little Southwest Miramichi Area 63
    2.4.2 Water Use-Little Southwest Miramichi . . . 65
  2.5 The Estuarine Tributary Area. 66
    2.5.1 General Discussion-Estuarine Tributary Area 66
    2.5.2 Water Use-Estuarine Tributary Area 70
  2.6 The Central Southwest Miramichi Area. 72
    2.6.1 General Discussion-Central Southwest Miramichi Area 72
    2.6.2 Water Use-Central Southwest Miramichi Area 74

CHAPTER PAGE

2.7 The Miramichi Bay Area. 76
2.7.1 General Disscussion-Miramichi Bay Area . 76
2.7.2 Water Use-Miramichi Bay Area 79

3. THE COMMUNITY WATER SUPPLIES 80
3.1 Introduction 81
3.2 The Village of Blackville 83
3.3 The Town of Chatham 86
3.4 The Village of Douglastown. 98
3.5 The Village of Loggieville. 104
3.6 The Village of Neguac 109
3.7 The Village of Nelson-Miramichi 111
3.8 The Town of Newcastle 115
3.9 The Village of Rogersville. 123

4. WATER MANAGEMENT CONSIDERATIONS. 127
4.1 Introduction 128
4.2 Protection of the Water Resource. 129
4.3 Protection of the Water Supply Watersheds . . . 132
4.4 Protection of Public Water Supply Wells 134
4.5 Flood Plain Considerations. 135
4.6 Monitoring the Water Resource 141
4.6.1 The Climatological Network 141
4.6.2 The Hydrometric Network. 142

LIST OF REFERENCES 145
LIST OF CONTRIBUTORS 148

APPENDIX

A. General Information. 149
B. Glossary 153
C. Industrial and Municipal Wastes in the Planning Region 166
D. Lists of Hydrometric, Climatological and Water Quality Stations in the Region 175
E. Flow Duration Curves of Hydrometric Stations in the Region 184
F. Lowflow Frequency Curves of Hydrometric Stations in the Region. 200
G. Physical Description of Selected Watercourses in the Planning Region. 215

LIST OF FIGURES

FIGURE PAGE

1.1 Parishes. 3
1.2 Mean Total Annual Precipitation (mm). 17
1.3 Mean Total Annual Snowfall (mm) 18
1.4 Physiography of the Region. 22
1.5 Bedrock Geology of the Region 25

2.1 The Areas 28
2.2 Available Water Resources 37
2.3 Upper Nepisiquit Area 54
2.4 Northwest Miramichi Area. 59
2.5 Little Southwest Miramichi Area 64
2.6 Estuarine Tributary Area. 67
2.7 Central Southwest Miramichi Area. 73
2.8 Miramichi Bay Area. 77

3.1 Site Locations - Village of Blackville. 84
3.2 Location of Wells - Chatham 88
3.3 Population and Water Demand - Chatham 92
3.4 Location of Pump House #1 - Douglastown 100
3.5 Location of Pump House # 2 - Douglastown. . . . 101
3.6 Test Well Site Locations Village of Loggieville 106
3.7 Water Sources - Nelson-Miramichi. 113

LIST OF TABLES

TABLE		PAGE
1.1	Population and Population Change in the Newcastle-Chatham Planning Region	12
1.2	1981 Household Count Newcastle-Chatham Planning Region	13
1.3	Climatological Data in the Newcastle-Chatham Planning Region	20
2.1	List of Major River Basins in the Region	31
2.2	List of Lakes	32
2.3	List of Dams	33
2.4	Median Nutrient Levels	42
2.5	Median Heavy Metal Concentration	44
2.6	Physical Parameters	46
2.7	Groundwater Quality of Selected Communities	52
3.1	General Information on Water Supplies and Waste Treatment Systems	82
3.2	Details of Production Wells in Chatham	89
3.3	Water Demand (1901-1981)-Town of Chatham	91
3.4	Per Capita Water Consumption (1981-1982) Chatham	91
3.5	Chemical Analysis (August 1982) - Chatham	95
3.6	Analysis of Conditions of Waste Water Treatment Plant - Town of Chatham	97
3.7	Chemical Analysis - Douglastown	102
3.8	Analysis of Conditions of Waste Water Treatment Plant - Douglastown	103
3.9	Water Quality Analysis (ABP Consultants, 1980) - Loggieville	107
3.10	Details of Production Wells - Newcastle	117
3.11	Water Consumption Data - Newcastle	119
3.12	Water Quality of Wells in Newcastle (July, 1982)	120
3.13	Analysis of Operating Conditions of Wastewater Treatment Plant - Newcastle	121
3.14	Analysis of Operating Conditions of Wastewater Treatment Plant #1 - Rogersville	125
3.15	Analysis of Operating Conditions of Wastewater Treatment Plant #2 - Rogersville	126
4.1	Historical Flood Events in Newcastle - Chatham Region	137

CHAPTER ONE

THE REGION

1.1 Introduction

The Newcastle-Chatham Planning Region, shown on Figure (1.1) covers an area of approximately 2290 square kilometres. Incorporated municipalities comprise roughly 40% of the total population of the planning region. Six out of a total of eight municipalities in the Newcastle-Chatham Region are situated along the Southwest Miramichi River and the estuarine Miramichi River.

In 1981, the twin ports of Newcastle and Chatham had a combined population count of 13,063, which represents a quarter (25%) of the total population count within Northumberland County. These towns, together, represent approximately 85% of the urban population (15,290) of the Planning Region. The two communities function as regional service centres for the settlements within the Miramichi River Basin and the Canadian Forces Base Chatham.

Chatham and Newcastle provide the shipping connection to overseas markets for the export of ore, pulp and other forest products and the port facilities for the delivery of oil fuels to two bulk storage facilities.

The total demand on Chatham's municipal water supply is approximately 5.68 million litres per day. The CFB Chatham is the town's biggest consumer with a demand of 0.72 million litres per day. The Town of Newcastle has a total water demand of 4.82 million litres per day. Recent metering of consumption by Domtar Chemicals Ltd., suggests that this industry is the major user of Newcastle's municipal water at approximately 0.55 million litres per day. This supplements the company's own groundwater supply. Both Newcastle and Chatham rely on groundwater sources.

Much of New Brunswick's wealth in forests, minerals and fisheries is found along the coast of Northumberland County and in the hinterland of the Miramichi River drainage basin. The Newcastle-Chatham Planning Region, is encompassed mainly within the boundaries of Northumberland County. The major industries within the planning region, Acadia Pulp and Boise Cascade, are forest oriented. Acadia pulp and paper uses approximately

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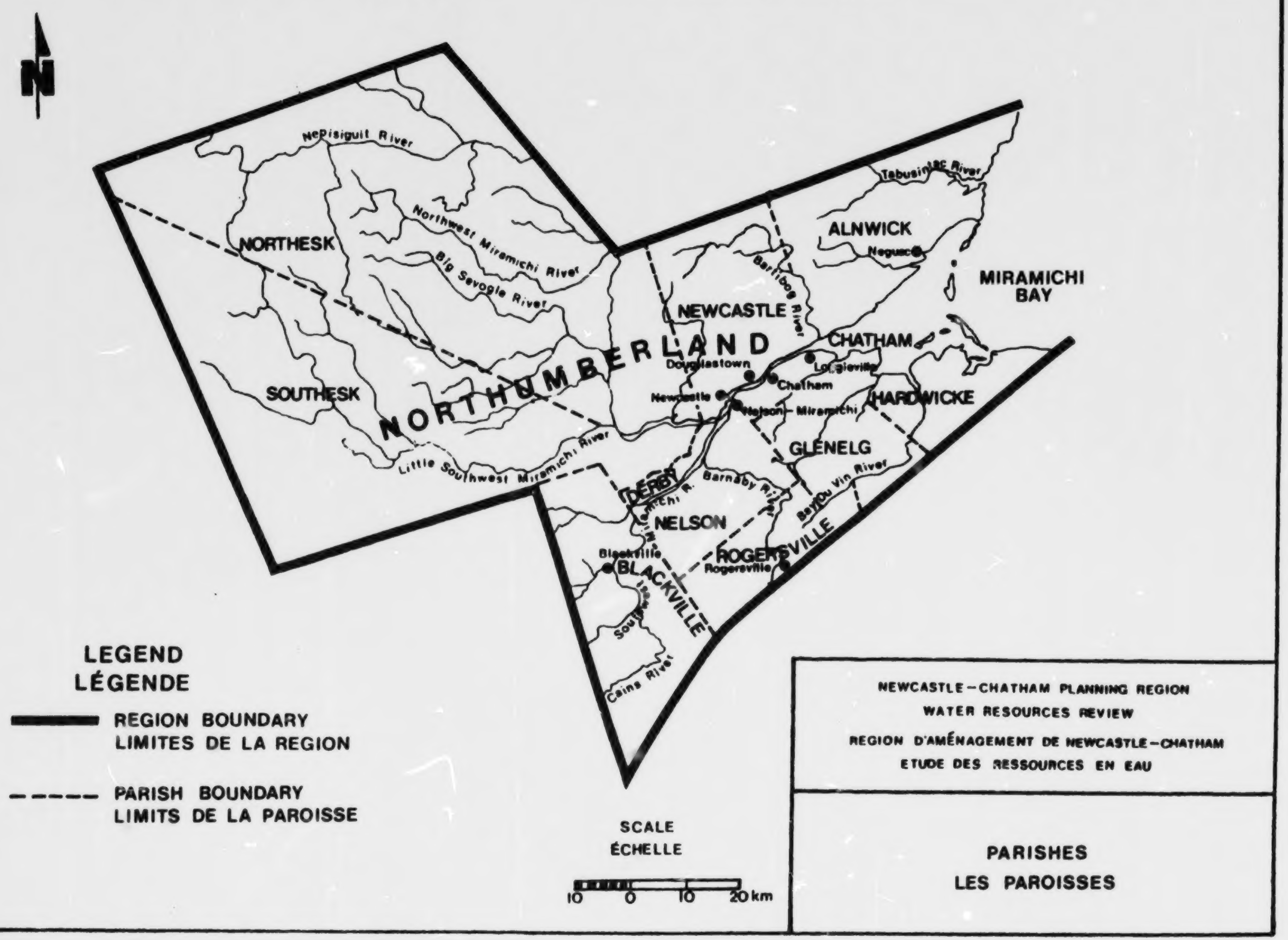
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Tabusintac River
ALNWICK
Neguac
MIRAMICHI BAY
CHATHAM
Douglastown
Loggieville
Chatham
Newcastle
Nelson-Miramichi
HARDWICKE
GLENELG
Bay Du Vin River
DERBY
Miramichi R.
Barnaby River
NELSON
ROGERSVILLE
Rogersville
Blackville
BLACKVILLE
Cains River
LEGEND
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LIMITES DE LA REGION
PARISH BOUNDARY
LIMITS DE LA PAROISSE
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NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

PARISHES
LES PAROISSES

FIG. I.I

5.68 million litres per day. Boise Cascade draws approximately 75.70 million litres per day from the Miramichi River for its processing needs.

Mineral exploration and mining activity is concentrated in the Northwest Miramichi Basin. Heath Steele Mines Ltd. is the only remaining mining operation. Approximately 160 million litres per day surface water from Little River Lake and the Little South Tomogonops River is used for its processing operations.

Tourism, peat moss, agriculture, (specifically the growing of brussel sprouts in the Rogersville area) and an endangered world famous salmon sport fisheries, contribute to complete the region's economic structure. There are a few secondary industries which are able to provide a stable employment situation and thus encourage economic expansion and population growth in this resource rich planning region. The demand on the region's water resources is not expected to increase in the near future. However, localized problems with water quality continue to concern several municipalities.

Recreational water use, specifically canoeing and angling, is mainly confined to the upper reaches of the Miramichi River basin. Pollution of the estuarine Miramichi and some stretches of the Northwest Miramichi threaten the migration and spawning habitat of the Atlantic Salmon. The maintenance of suitable water quality for the region's fisheries resource is a major concern in the Planning region.

1.2 History

To be acquainted with an overview of a community's history is to provide the observer with a clearer perspective from which to view a region's cultural, environmental and economic fabric. The forces which shaped history have evolved and continue to influence development. It is helpful to identify these influences in an effort to anticipate a region's future resource needs - in this instance, the demands placed upon the water resource. The following is an abbreviated summary of some of the historical events which have shaped the Miramichi, that is to say, the Newcastle-Chatham Planning Region, during the last three centuries.

1.2.1. Pre-Confederation Period

Historically, the name "Miramichi", is the oldest Indian place name in Eastern Canada. The Micmacs, a relatively peaceful Algonquin Indian Tribe who inhabited the coast of New Brunswick and Nova Scotia from the Gaspé to Cape Breton Island and are said to possess a language which can express the ideas more subtly than the Greek, called the Miramichi River the "Lustagoocheehk - the little goodly river. Miramichi is probably a Montagnais Indian word meaning "Micmac Land". In the early 1600's the name was recorded on Samual D. Champlain's map as the River Mariameschie. For over 10,000 years prior to colonization by Europeans, semi-nomadic Micmacs roamed the river valley and shores living off the bounty of the land and sea, hunting, fishing and growing a few crops. Three Micmac reservations are still maintained on the Miramichi - Burnt Church, Eel Ground and Red Bank.

For many years the first Europeans in the area lived much the same way as did the Indians and no attempt was made to settle the land. It is known that the sandy beaches at the mouth of the Miramichi Bay had been used by Basque and French fishermen to dry their catch since the early 1500's. In 1534, when Jacques Cartier sailed across Escuminac Point, he noted that the Indians did not seem surprised to see a white man. He recorded the sighting of "a bay in the fashion of a triangle, which is very deep, which as far as we could see lies north-east and it is all ranged with sands". (Fraser, 1964).

In the next two centuries the county changed hands many times, sometimes held by the French and sometimes by the English. Bearing in mind that early boundaries were not clearly defined, in the period from 1534 to 1763 the Miramichi area changed hands seven times. The Acadian census of 1682 lists only six people on the Miramichi. Richard Denys de Fronsac was one of these.

Repeated attempts to establish Acadian outposts as seigneurial agricultural and fishing settlements in north-east New Brunswick appear to have failed but a few small communities dependent on fishing and subsistence farming remained after Acadia was ceded to the British in 1713. By 1763, the British had established undisputed sovereignty and the British "Preloyalist" settlement with its woodland based economy was established.

The modern settlement of the Miramichi dates from 1765. That year a 100,000 acre grant was given to two Scots, William Davidson and John Cort, who chose the Miramichi River because of its immense salmon fishery. Although their grant was intended as a fishing grant, they received the standard grant of 100,000 acres on what was described as the River Mariameschie.

A trade in fish and furs was built up and in 1773 the first ship to be built here, the 300 ton "Miramichi" was launched from Davidson's shipyard on Beaubear's Island.

With the coming of the French, after the Acadian Explusion from Nova Scotia in the late 1700's, and the English, when ships coming from Britain to take on lumber brought immigrants in the late 1700's and 1800's, the land gradually got settled. At the close of the American Revolution some Loyalists and disbanded soldiers settled the Miramichi and old settler's grants were surveyed and parcelled out in 200 acre lots with a sixty-foot front. During and after the Napoleonic Wars, British migration increased. A period of prosperity in the Miramichi began as a result of the closing of the Baltic ports to Britain and the consequent great demand for pine and later spruce. Towns and villages were established along the shores of the river. The sparce population rapidly expanded and Newcastle, Douglastown, Nelson and Chatham prospered.

Agricultural development was shunned for the rich investment offered by lumbering. Most of the food had to be imported by coastal vessels. "The Miramichi had almost no indigenous demand for its major products. The economy was dependent on international demand for lumber and fish and to a lesser extent, shipbuilding." (Public Works Canada, 1978).

Timber cut in the woods each winter was driven down the Miramichi and its tributaries in the spring to the lumber mills which dotted the river's shores. Lumbering was always a transient occupation, requiring no fixed capital. Land owners were attracted by the quick return. Water driven sawmills elsewhere in the Maritime gave a basis to a more solidly based economy but the absence of fast water near the lower reaches of the Miramichi precluded this type of development. The export of long lumber, spars masts and squared lumber to Great Britain continued to form the mainstay of the local trade until well into the nineteenth century when stream driven sawmills were introduced.

The combination of unrestrained or indiscriminate logging and forest fires shifted emphasis to sawmill products based on the less profitable spruce. Thus ended the relative prosperity of smaller landowners and entreprenuers who had relied on the forests of large pine.

The Great Fire of Miramichi on October 7, 1825 destroyed 75,000 km^2, wasted the settlements of Newcastle and Douglastown and left the country between Nashwaak and Bartibog Rivers in charred ruins. The masting industry was finished but the Miramichi was entering its 'golden age' of shipbuilding. In the next fifty years, shipbuilding prospered and reached its peak in 1850. At first, building was restricted to the needs of the local trade but soon the ships of the Miramichi became known in ports all over the world. The last square-rigger was built in 1880 in Newcastle. Steam ships came of age and the forest industry became Northumberland County's chief employer.

The demise of the ship building industry in the 1870's was probably due to the supplanting of wood by steel in hull construction, poor international trade conditions and the impact of the railway which could now provide overland connections with other Canadian east coast ports. Transportation by sea until then had rendered overseas markets almost as accessible as inland communities. Harris and Warkentin (1974) suggest "As a result the Atlantic Region has an elusive quality, composed of persistent subregional parochialism and simultaneous easy connections with the outside world".

It is probably not coincidental, then, that the first significant efforts made between 1872 and 1882 to deepen the navigational channel through the Miramichi estuary were initiated, efforts which were to continue intermittently until today.

1.2.2 Confederation Period

In the last years of the 19th century and the first half of the 20th century, lumbering was based on the export of sawn lumber, poles and pit-props and was the area's major activity. As in the rest of Canada, economic and social conditions were bad through the nineteen thirties until the second world war stimulated demand. Following the war, the current phase of development began.

In the 1950's the defence services emerged as a basic sector of the Miramichi region's economic base. The mining sector also assumed a major role during the 1960's with the establishment of the Heath Steele Mines Limited mine-mill complex on Little River in the north of the planning region.

The traditional reliance on the forest resource has been intensified. Two of the Province's pulp mills are located in the region. The number of lumber mills has declined as a result of a reduced market and a decreasing supply of saw logs. The region at one time is reported to have had the most diversified wood industries in Atlantic Canada. (Miramichi Region Development Corporation, 1978).

The commercial fisheries sector has continued to perform a role within the Miramichi economy but on a more modest scale. Although there are as many as 22 commercial species of fish in the Miramichi River system and estuary, fish processing has not developed significantly. The vulnerable Atlantic Salmon migrate through the estuary to spawn in the river reaches and provide a diminishing base for the region's famous sport fisheries. The annual average value of commercial fishing is $1.5 million and the dollar value of recreational fisheries is approximately $2.8 million annually. On the other hand, the value of pulp production in the area, amounting to nearly 300,000 t/year is approximately $90 million (Montreal Engineering, 1976).

Agriculture in the Miramichi remains an activity of small importance. However, the cultivation of brussel sprouts for the frozen food market may contribute to the economic well being of growers in the Rogersville area.

The pulp mills and mining operation depend largely on overseas markets and marine transport continues to be a mainstay of the region. The ports of Chatham and Newcastle, 45 km and 53 km respectively from the Gulf of St. Lawrence, remain open all year and handle approximately 180 ships annually with a total cargo weight of 1 million tons. Together these towns are the second largest port in New Brunswick and the fourth largest in the Atlantic Region. The original 5 meter deep channel has been improved over the years to allow passage for 14000 d.w.t. vessels at a draft of 7.6m. The navigation channel extends for 64 km, (Miramichi Channel Study, 1978). Petroleum produce unloadings to two product distribution terminals on the Miramichi estuary represent the greater part of the cargo handled.

Since the mid-1970's there has been a "prolonged pause" in the region's economic growth, (Miramichi Development Corporation, 1978). Poor markets for woodpulp and lumber combined with recessionary conditions throughout North America have resulted in the closure of a number of pulp mills and several sawmills. During the period between 1974 and 1976 the decline in the volume of wood harvested, mostly in pulpwood has been around 17%. The rate of tree harvesting required to sustain the present mills is greater now than in the past and potential for further expansion appears to be quite limited.

The impending shut down of Heath Steele Mines Ltd. in the winter of 1982 and the possible reduction of the defence services, announced in the fall of 1982, may further de-stablize the economy of the region.

Much of New Brunswick's wealth in natural resources, forests, minerals and fisheries - lies in Northumberland County and the Miramichi region. Mining, commercial and sport fisheries, peat moss and tourism are included in the region's economic structure. However, future economic progress and consequently the demand for the regions water resources, will be influenced significantly by changes in the forestry sector with its related industries, the mining sector and the continuation of the defence services in the Chatham-Newcastle Region.

Future industrial or community development decisions will be based on the availability of suitable water. The optimum utilization of the region's water resources must be determined among the various uses likely to be placed upon it. A public awareness of environmental issues which began in the 1960's has led to the establishment of various government agencies. Today the task of protecting and managing the water resources of the province rests with the New Brunswick Department of the Environment, supported by the activities of Environment Canada, some of the provincial agencies and municipalities.

1.3 Population and Housing Characteristics

The Newcastle-Chatham Planning Region contains eight incorporated municipalities. Two of these are towns, Newcastle and Chatham; and six are villages, Blackville, Douglastown, Loggieville, Nelson-Miramichi, Neguac and Rogersville.

Population and household data for the Region has been prepared from the 1981 Census, which is the most recent available. The census data has been organized, for water resource management purposes, according to the Water Survey of Canada (WSC) drainage basin areas. Since these areas typically do not correspond with census enumeration area boundaries, the population of each census unit was assigned to the basin in which the majority of residents live.

The figures and tables provided in this section illustrate the various population and housing characteristics of the region. It should be noted that the data presented here contain both sampling and rounding errors which are part of the census taking process. Actual values reported are, therefore, approximations and should be interpreted as such.

Although the parishes of Ludlow and Blissfield are outside the boundaries of this Planning Region, they comprise part of the drainage basins 1BO and 1BN, which are reviewed in their entirety in this report. In fact, the population distribution of the Newcastle-Chatham Planning Region approximately represents the population of the county of Northumberland. Portions of drainage basin areas outside the county boundaries do not represent settled areas of the Province. The population distribution has been interpreted from the 1981 census data and from National Topographic Series 1:50,000 maps. It indicated only a generalized pattern of population settlement and density rather than exact locations of residences.

Most of the population of the Newcastle-Chatham Planning Region is found along the Southwest Miramichi and the estuarine Miramichi River Valley. Six of the region's incorporated communities, representing 33% of the region's total population, are situated along the Southwest Miramichi and the main River (the Estuarine Tributary area 1BO). There is scattered settlement along the north and south coasts of the Inner Miramichi Bay area and along the lower Northwest Miramichi River.

Table (1.1) documents the 1981 Census population for each of the planning areas in the Planning Region, as well as the change in population from 1976 to 1981. Table (1.2) similarly documents the distribution of households among the various planning areas in the Region. The number of households has been broken down into incorporated (i.e. within incorporated municipalities) and non-incorporated categories.

The approximate population of the Newcastle-Chatham Planning Region in 1981 is 52,000. (The 1981 census population count for Northumberland County is 54,134). Assuming that the population change within Northumberland County represents, as well, the population change within the Newcastle-Chatham Planning Region, there has been a very slight but constant change of 4% over the past decade (1971-1981).

Total households in the region numbered 14,686 of which 6,100 (42%) are found within incorporated municipalities. Roughly 39% of the total population of the Newcastle-Chatham Planning Region resides within incorporated communities.

TABLE (1.1) POPULATION AND POPULATION CHANGE IN THE NEWCASTLE-CHATHAM PLANNING REGION

PLANNING AREA	POPULATION		POPULATION CHANGE 1976-1981	
	1976	1981	ABSOLUTE	%
Upper Nepisiquit (1BK)				
Northwest (1BQ) Miramichi	2910	2880	-30	1
Little Southwest Miramichi (1BP)	1774	1924	150	8
Estuarine Tributary (1PO)	31770	31365	- 405	1
Central Southwest Miramichi (1BN)	2572	2552	-20	1
Miramichi Bay (1BL, 1BR)	12748	13218	470	4

Source: Census of Canada, 1976, 1981

TABLE (1.2) 1981 HOUSEHOLD COUNT, CHATHAM-NEWCASTLE PLANNING REGION

PLANNING AREA	NUMBER OF HOUSEHOLDS		
	INCORPORATED[1]	NON-INCORPORATED[1]	TOTAL
Upper Nepisiguit (1BK)	-	-	-
Northwest (1BQ)	-	835	835
Little Southwest Miramichi (1BP)	-	552	552
Estuarine Tributary (1BO)	5644	3486	9130
Central Southwest Miramichi (1BN)	-	807	807
Miramichi Bay (1BL, 1BR)	455	2907	3362

Source: Census of Canada 1976

[1] Note: This Designation is not synonomous to urban which is defined for census purposes as a community of 1000 with a population density of 400 km2.

The Upper Nepisiguit Area (1BK)

This area is mainly forest wilderness. Activity is centered on mineral exploration and harvesting of forest resources. For purpose of this report, the portion of drainage basin 1BK within the Planning Region is considered to be unpopulated.

Northwest Miramichi Area (1BQ)

There are no incorporated municipalities within the Northwest Area. Rural settlement is along the lower Northwest Miramichi which flows southerly through the lower portion of the Northesk Parish. The upper half of this Parish is mainly forest wilderness and activity there is centered on mineral exploration and lumbering. Parish statistics, therefore, are assumed to represent the approximate population of the Northwest area as well. The 1981 census population of this area was 2,880. This indicates a slight decrease (1%) since the 1976 census count of 2,910. There are 835 occupied dwellings in this area.

Little Southwest Miramichi Area (1BP)

The Little Southwest Miramichi Area occupies the greater portion of Southesk Parish in Northumberland County. The portions of the county excluded from the Basin area represent wilderness forest in the Miramichi Highlands.

This is the least populated area in the Planning Region. There are no incorporated municipalities located within this area.

Assuming that census figures for the Parish of Southesk approximate the actual population statistics for the Little Southwest Miramichi area as well, the 1981 census population is 1924. This is an increase of 8% over the 1976 population. There are 552 occupied dwellings in Little Southwest Miramichi Basin Area.

Central Southwest Miramichi (1BN)

Although this area encompasses portions of three Northumberland County parishes as well as portions of parishes in both York and Sunbury Counties, the Central Southwest Miramichi area contained within the Northumberland County reach of the Southwest Miramichi represents virtually all of the settlement in this area (with the exception of the Village of Holtville in Northumberland County, a municipality included in the Fredericton Planning Region). The northern half of Ludlow and Blissfield

Parishes and the southern half of Blackville parish are assumed to have no significant population counts. This being the case, the 1981 census figures for the two first mentioned parishes are 2,552 people occupying 807 dwellings. Assuming this count to represent the population of the Central Southwest Miramichi Area, a population decrease of about . 1% has occurred since 1976.

Estuarine Tributary Area (1BO)

The Estuarine Tributary area encompasses all but one of the Newcastle-Chatham Planning Region's incorporated municipalities. The 1981 population of this area was approximately 31,365, a decrease of 400 or 1% over the 1976 census count of 31,770. Most of the settlement in this area is along the Southwest Miramichi and the estuarine Miramichi River. Households in the area number approximately 9,130, 60% of which are within incorporated municipalities.

Miramichi Bay Area (1BL, 1BR)

The Miramichi Bay Area contains only one incorporated municipality, the Village of Neguac. Neguac has the largest population (1,755 persons) of all the villages located within the Newcastle-Chatham Planning Region. The Miramichi Bay area's boundaries include almost all of the Parishes of Chatham, Alnwick, Glenelg and Harwick. The 1981 population of this area is therefore about 13,218 with the number of occupied dwellings totalling 3,362.

This represents an increase of population of approximately 4% over the 1976 census figures (12,748) for the same area. The rate of population change in the Miramichi Bay Area has remained constant over the last ten year period.

1.4 Climate

The Newcastle-Chatham Planning Region is located in east central New Brunswick. It lies between 47° 33'N and 46° 24'N and between 67° 03'W and 64° 48'W.The northwestern half of the region is located mainly within the New Brunswick (Miramichi) Highland physiographic division. The southeasterly half of the region lies within the Gulf of St. Lawrence Plain. The elevation of the land falls below 0-50m along the coastal plain to above 300m in the Miramichi Highland region.

The climate of the Miramichi River Basin Area, which is largely governed by the large continental land mass to the west and to some extent also affected by the waters of the Gulf of St. Lawrence, is relatively cool and humid. Records based on 30 years, 1951-1980 at Chatham Airport, Environment Canada, show the mean daily temperature to be 4.8°C, the mean daily maximum temperature as 10.2°C and the mean daily minimum temperature as -0.6°C. The mean warmest month is July with a mean daily maximum temperature of 25.2°C. The mean coldest month is January with a mean daily minimum of -14.8°C.

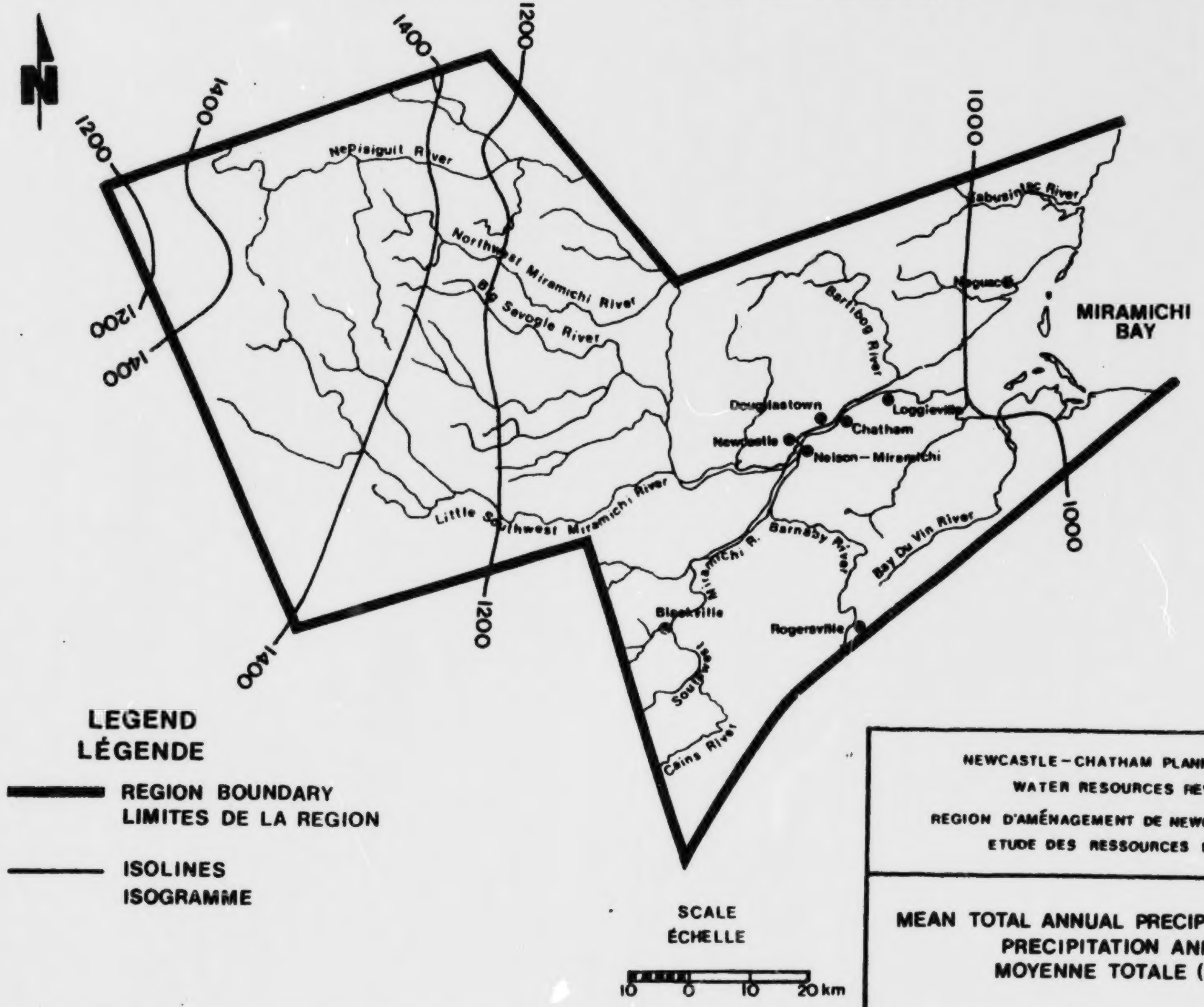
By November 10, much of the land situated more than 150m above mean sea level in the northwestern portion of the region has snow cover. The winter season (defined on the basis of snow cover records of dates when snow is on the ground to the depth of 2.5 cm or more) lasts approximately five or five and one half months. Even at the end of April,terrain about 300m elevation can remain snow covered. The median duration of the snow cover season ranges from between 150 days along the Estuarine Miramichi and 170 days in the New Brunswick Highlands.

About one-third of the total precipitation over north-western portion of the region is in the form of snow. Total annual precipitation is the sum of the annual rainfall plus one tenth of the annual snowfall . The mean total annual snow varies from 225 cm in the Miramichi Bay Area to about 400 cm in the Highland Region. The snow fraction (percentage of precipitation falling as snow) is lower near the ocean or Miramichi Bay area. Most of the annual snowfall occurs from December to March but near the Atlantic, six to ten rain days can be experienced monthly as well. (Gates, 1975).

Although mean annual precipitation amounts vary somewhat over the Newcastle-Chatham Region, the year to year variation of snowfall amounts in the northern part of New Brunswick is not great (Gates, 1975). Precipitation records at Chatham Airport (Environment Canada) for the period 1951-1980 show a mean total precipitation of 1096.7mm consisting of 760.6mm of rainfall and 333.1 cm of snowfall. Figures (1.2) and (1.3) show the mean total annual precipitation in mm and the mean total annual snowfall in cm, respectively within the planning region. The largest amount of seasonal (May to September) rainfall occur along the Atlantic Coastline and over the higher elevations inland where totals can average 500 mm or more. (Gates, 1975).

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU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MIRAMICHI BAY
Nepisiguit River
Northwest Miramichi River
Big Sevogle River
Little Southwest Miramichi River
Bartibog River
Tabusintac River
Neguac
Douglastown
Chatham
Loggieville
Newcastle
Nelson - Miramichi
Miramichi R.
Barnaby River
Bay Du Vin River
Rogersville
Blackville
Southwest
Cains River
LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA REGION
ISOLINES
ISOGRAMME
SCALE
ÉCHELLE
10 0 10 20 km

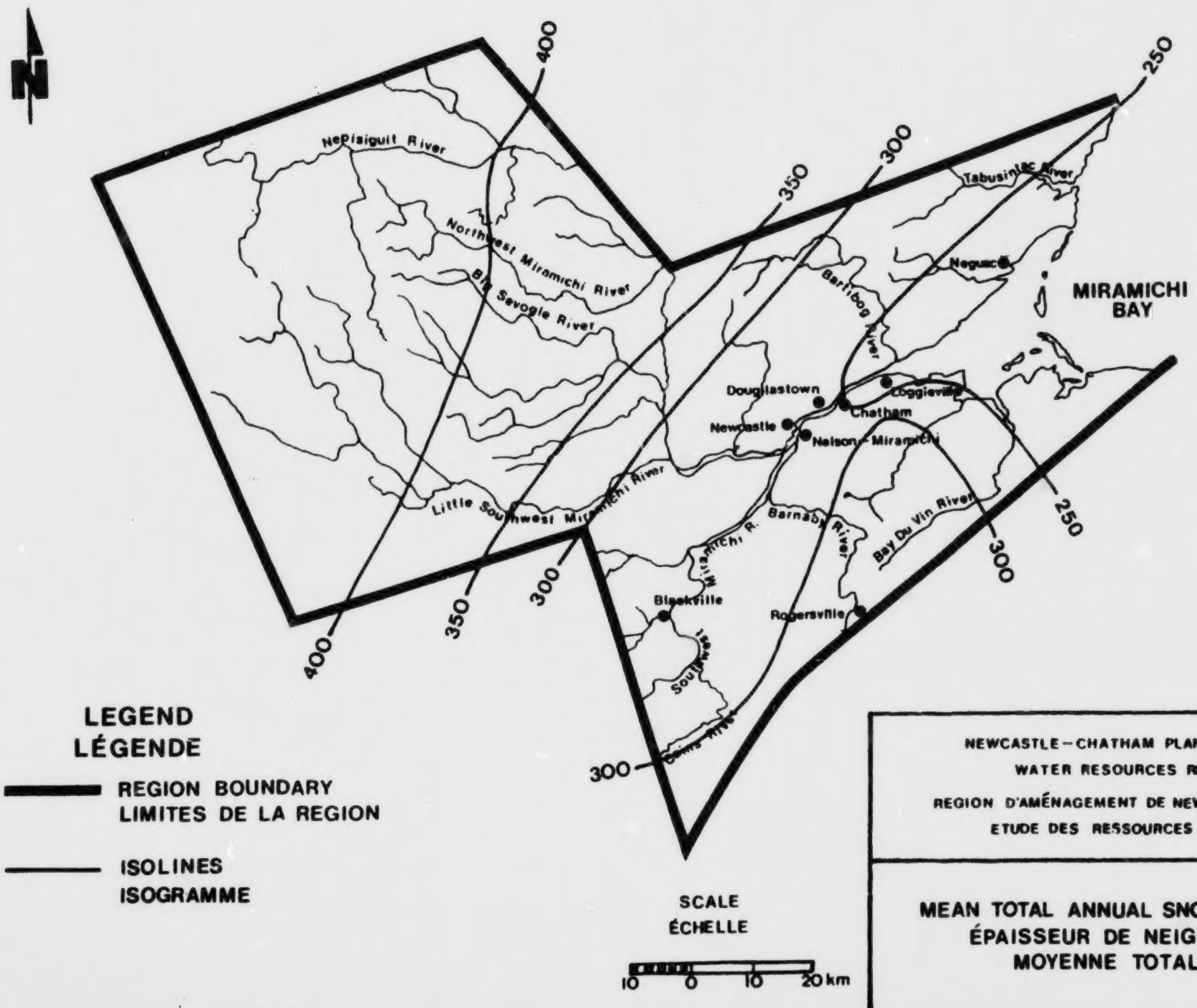
NEWCASTLE - CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE - CHATHAM
ETUDE DES RESSOURCES EN EAU

MEAN TOTAL ANNUAL PRECIPITATION (mm)
PRECIPITATION ANNUELLE
MOYENNE TOTALE (mm)

FIG. 1.2

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
400
350
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Nepisiguit River
Northwest Miramichi River
Big Sevogle River
Little Southwest Miramichi River
Bartibog River
Tabusintac River
Neguac
MIRAMICHI BAY
Douglastown
Chatham
Loggieville
Newcastle
Nelson-Miramichi
Barnaby River
Bay Du Vin River
Miramichi R.
Blackville
Rogersville
Southwest
Cains River
LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA REGION
ISOLINES
ISOGRAMME
SCALE
ÉCHELLE
10
0
10
20 km

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

MEAN TOTAL ANNUAL SNOWFALL (cm)
ÉPAISSEUR DE NEIGE ANNUELLE
MOYENNE TOTALE (cm)

FIG. I.3

The mean driest month in the Newcastle-Chatham Region is May and the wettest month is December. The shortest complete summer season occurs in the highland region where the duration of summer and winter seasons are almost equal. For more climatological information, refer to Table (1.3).

Temperature and precipitation data listed in Table (1.3) is secured from all climate stations in the Planning Region for which at least five years of records exist. There are five active climatological stations in the Newcastle-Chatham Planning Region. Further details related to the climate of the region can be obtained from Environment Canada, Meteorological Applications Branch, (Gates, 1975) and from the Atmospheric Environment Service Branch publication, Canadian Climate Normals, Temperature and Precipitation, 1951 - 1980. Table (D.3) presents a listing of both active and inactive climatological stations located within the Newcastle-Chatham Region.

TABLE (1.3) CLIMATOLOGICAL DATA FOR NEWCASTLE-CHATHAM PLANNING REGION

	STATION					
CLIMATOLOGICAL PARAMETER	Chatham A	Little River Mine	McGraw Brook	Mount Carleton	Renous*	Upsalquitch Lake
ANNUAL TEMP.						
Mean Daily °C	4.8	3.0	4.3	2.6	4.2	1.6
Mean Daily Maximum °C	10.2	8.1	10.4	8.8	10.5	5.6
Mean Daily Minimum °C	-0.6	-2.2	-1.9	-3.6	-2.2	-2.3
EXTREME TEMP.						
Maximum °C	37.8	35.0	37.8	34.5	36.1	31.7
Minimum °C	-35.0	-37.2	-37.8	-38.3	-38.9	-35.0
ANNUAL PRECIPITATION						
Mean Rainfall mm	760.6	762.3	801.1	686.8	790.8	608.9
Mean Snowfall cm	333.1	376.2	311.0	325.2	272.0	384.7
Mean Total Precipitation mm	1096.7	1134.3	1116.2	991.9	1081.5	909.6

SOURCE: Environment Canada, Canadian Climate Normals, 1951 - 1980 Temperature and Precipitation, Atlantic Provinces.

*Station Inactive

1.5 Physiography and Geology

New Brunswick is an extension of the system of uplands and highlands of the Appalacian Region of eastern North America. The Newcastle-Chatham Region encompasses two of these physiographic divisions: The New Brunswick Highlands and the Gulf of St. Lawrence Plain. These divisions are shown on Figure (1.4).

The Miramichi River Basin, part of the Atlantic-Gulf of St. Lawrence drainage area, originates in the Uplands and Highland Region of New Brunswick. Its many parallel tributaries drain the northwestern watershed, unite in the central part of the New Brunswick lowland area of the plain and then flows easterly as one main river to empty into the Miramichi Bay.

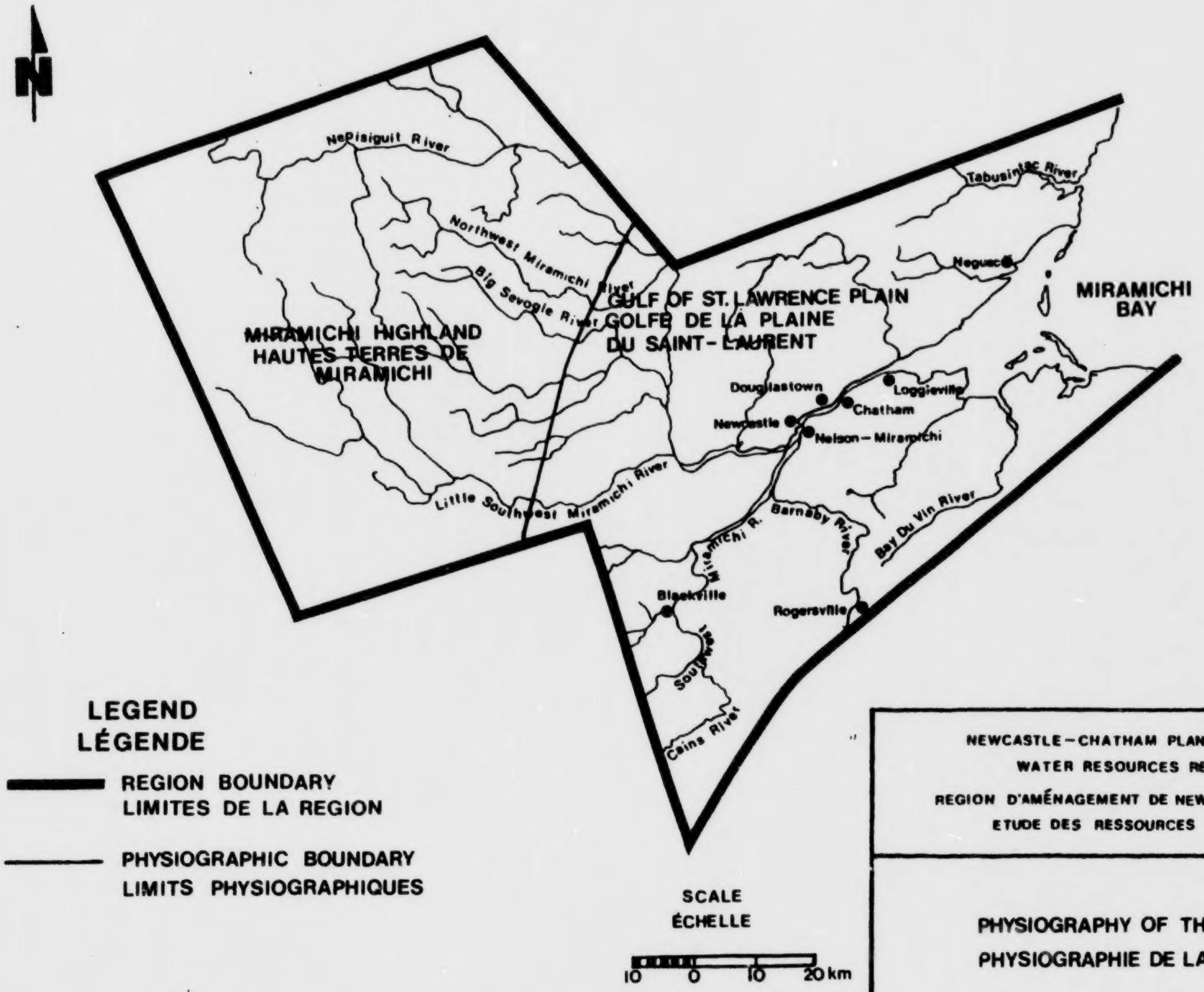
The Miramichi Watershed divide reaches a maximum elevation of over 672 m at Bald Mountain in the Miramichi Highlands. The rest of the western watershed ranges in elevation from 300 m to 600 m above sea level. There are only a few large lakes, numerous small pools and small lakes and these are found in the Miramichi Highlands.

The Chaleur Uplands form a peneplain ranging in elevation from 250 m to 300 m above sea level. Swampy plains and numerous lakes characterize the Uplands. Some of the peaks which break the regularity of the plain attain elevations in excess of 610 m (Mt. Carleton, the highest peak in New Brunswick is 820 m). Except for a few small areas where Upper Paleozoic rocks are found, the Chaleur Uplands are underlain by Lower Paleozoic sedimentary rocks, consisting chiefly of shale, sandstone and limestone. Most of the land is still forested. The Upper Nepisiquit River drains out of the Chaleur Uplands as does the headwaters of the Southwest Miramichi.

The Miramichi Anticlinorium which forms a northeasterly trending belt through the centre of New Brunswick and is one of five tectonic divisions in Central New Brunswick containing highly deformed and metamorphosed sedimentary and volcanic rocks of Cambrian to Middle Ordovician age. (Irrinki, 1980) The Ordovician strata of the Miramichi Anticlinorum contain economically exploitable ore deposits. Complex metamorphism within the northern part of the Newcastle-Chatham Region is of higher grade than is generally found in the Miramichi Highlands but the previously unrecognized presence of Ordovician felsic metavolcanic rocks, similar to those of the Bathurst area, are suggestive of stratiform sulphide deposits in this part of the region as well. (Irrinki, 1979).

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
Nepisiguit River
Northwest Miramichi River
Big Sevogle River
MIRAMICHI HIGHLAND
HAUTES TERRES DE MIRAMICHI
GULF OF ST. LAWRENCE PLAIN
GOLFE DE LA PLAINE DU SAINT-LAURENT
Tabusintac River
Neguac
MIRAMICHI BAY
Douglastown
Loggieville
Chatham
Newcastle
Nelson-Miramichi
Little Southwest Miramichi River
Barnaby River
Bay Du Vin River
Miramichi R.
Blackville
Rogersville
Southwest
Cains River
LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA REGION
PHYSIOGRAPHIC BOUNDARY
LIMITS PHYSIOGRAPHIQUES
SCALE
ÉCHELLE
10
0
10
20 km

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

PHYSIOGRAPHY OF THE REGION
PHYSIOGRAPHIE DE LA RÉGION

FIG. I.4

The undulating topography in the eastern part of the Miramichi Highland area is a result of gently dipping metasedimentary rocks. The higher hills in the west are underlain by Ordovician granite and gabbro. Since these igneous rock types exhibit a greater resistance to erosion, the Highlands are characterized by a rugged topography with many rock outcrops.

The headwaters of the Northwest Miramichi River, the Renous River and the entire Sevogle River Basin lie within the New Brunswick Highlands.

The headwaters of all branches of the Miramichi River are underlain by the older rocks. In general the headwaters of the Southwest Miramichi and the Little Southwest Miramichi are underlain by the granitic rocks which cause a number of rapids, mainly in its upper reaches, while the headwater areas of the Northwest Miramichi are underlain by less resistant rocks. (Miramichi Channel Study, 1978).

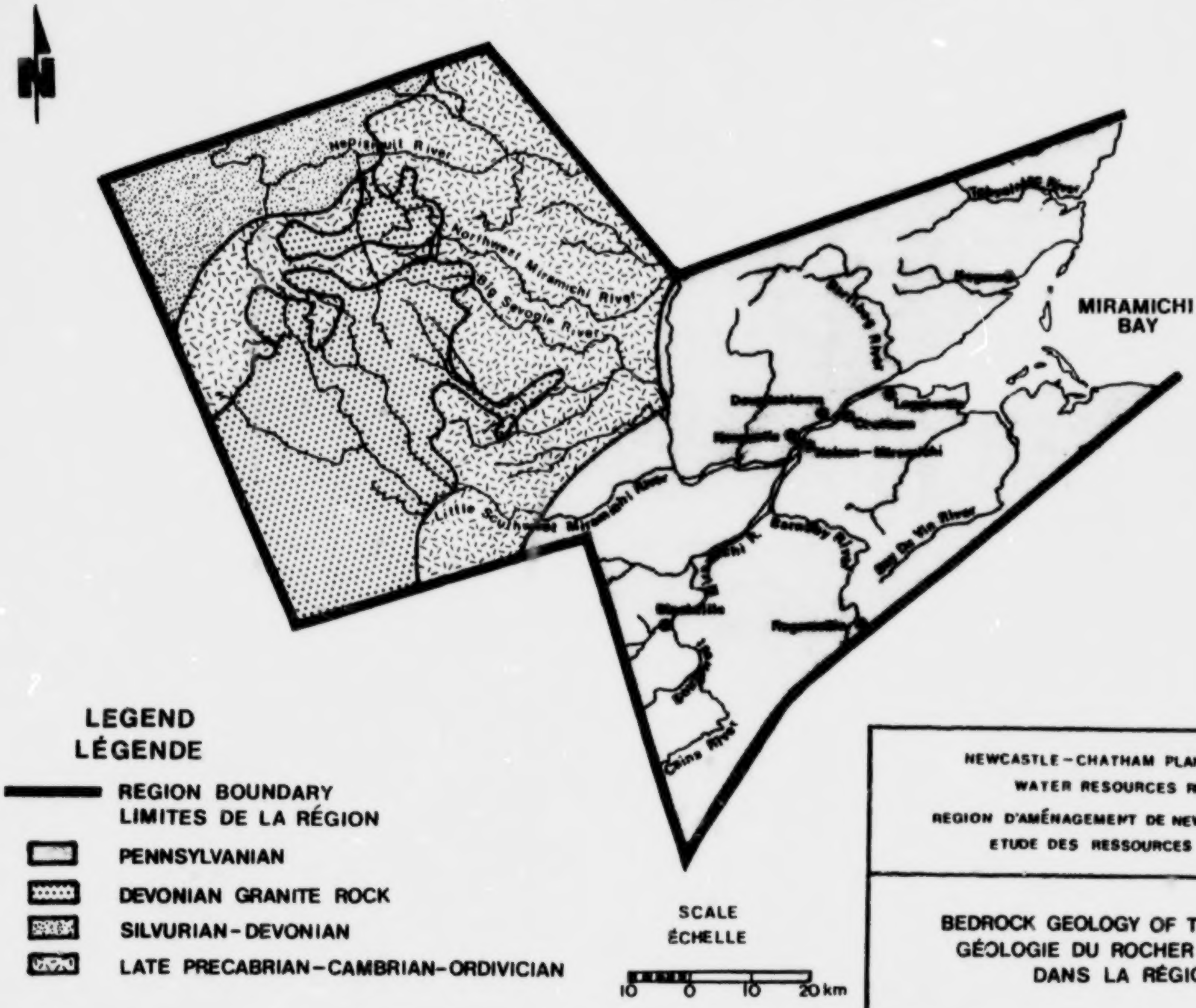
The New Brunswick Lowland, that portion of the Gulf of St. Lawrence Plain which lies between the two arms of the Highland Region, is formed by an area of flat or gently dipping Upper Paleozoic sedimentary rocks. The rocks have formed from continental or brackish water sediments and are chiefly sandstones, shales and conglomerates, accompanied by lesser amounts of coal, gypsum, anhydrite and limestone. They have not been folded to the same extent as the older rocks of the Lower Paleozoic Age and are less compacted and more easily eroded. Relief in the area is gentle and rarely exceeds 180 m above sea level.

The Newcastle-Chatham Planning Region was glaciated during the Pleistocene Epoch. Surficial deposits throughout the region consist mainly of glacially derived material. The bulk of the area has a discontinouous cover of glacial till that is commonly up to one or two metres thick and locally thicker. Gravel and sand deposits are fairly common at lower elevations. These include moderately thick but very localized ice-contact surficial deposits, and glaciofluvial outwash and deltaic deposits frequently having somewhat greater extent. Alluvial gravels and sands are common along present watercourses, but these are frequently rather thin.

Ice movement was, apparently, from west to east (Anderson 1970) in the New Brunswick Lowland Region. Erratics and topography in the northwest part of the region indicate ice movement from northwest to southwest (Skinner, 1975). The bedrock geology of the Newcastle-Chatham Planning Region is shown in Figure (1.5).

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
Nepisiguit River
Northwest Miramichi River
Big Sevogle River
Little Southwest Miramichi River
Chatham
Barnaby River
Bay Du Vin River
Cains River
MIRAMICHI BAY
LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA RÉGION
PENNSYLVANIAN
DEVONIAN GRANITE ROCK
SILVURIAN-DEVONIAN
LATE PRECABRIAN-CAMBRIAN-ORDIVICIAN
SCALE
ÉCHELLE
10
0
10
20 km

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

BEDROCK GEOLOGY OF THE REGION
GÉOLOGIE DU ROCHER EN PLACE
DANS LA RÉGION

FIG. I.5

CHAPTER TWO

THE WATER RESOURCES

2.1 Regional Review by Area

The surface and groundwater availability and quality in the Newcastle-Chatham Planning Region are discussed in this chapter. The region has been divided into six areas according to the hydrometric drainage index subdivisions defined by the Water Survey of Canada.

Detailed descriptions of each area, including location, major watercourses and surficial bedrock geology, are presented in this chapter. Major domestic and industrial water users and major water-based activities are also defined and discussed for each of the areas.

Additional information related to each of the six areas can be found in Appendices D, E, and F of this report. Such information includes lists of hydrometric, climatological and water quality stations, flow duration analyses and low flow frequency analyses of available historical data at the hydrometric stations. A comprehensive list of watercourses in each area is presented in Appendix G. This list provides drainage area, basin length, basin perimeter and basin shape coefficients for each watercourse. These coefficients are defined in Appendix B.

2.1.1 Preamble

Detailed reviews of the water resources in the six areas within the Newcastle-Chatham Planning Region are presented in the following sections. The designation of each of these areas, which are shown in Figure (2.1) is given below along with the area name.

Upper Nepisiguit Area	Drainage Index Subdivision 1BK
Northwest Miramichi Area	Drainage Index Subdivision 1BQ
Little Southwest Miramichi Area	Drainage Index Subdivision 1BP
Estuarine Tributary Area	Drainage Index Subdivision 1BO
Central Southwest Miramichi Area	Drainage Index Subdivision 1BN
Miramichi Bay Area	Drainage Index Subdivision, 1BR,1BL

None of the six areas in the Newcastle-Chatham Planning region lie entirely within the boundaries of the region. While 70 percent of the drainage basin of the Nepisiguit River (1BK) lies within the Chatham-Newcastle planning region, the Nepisiguit

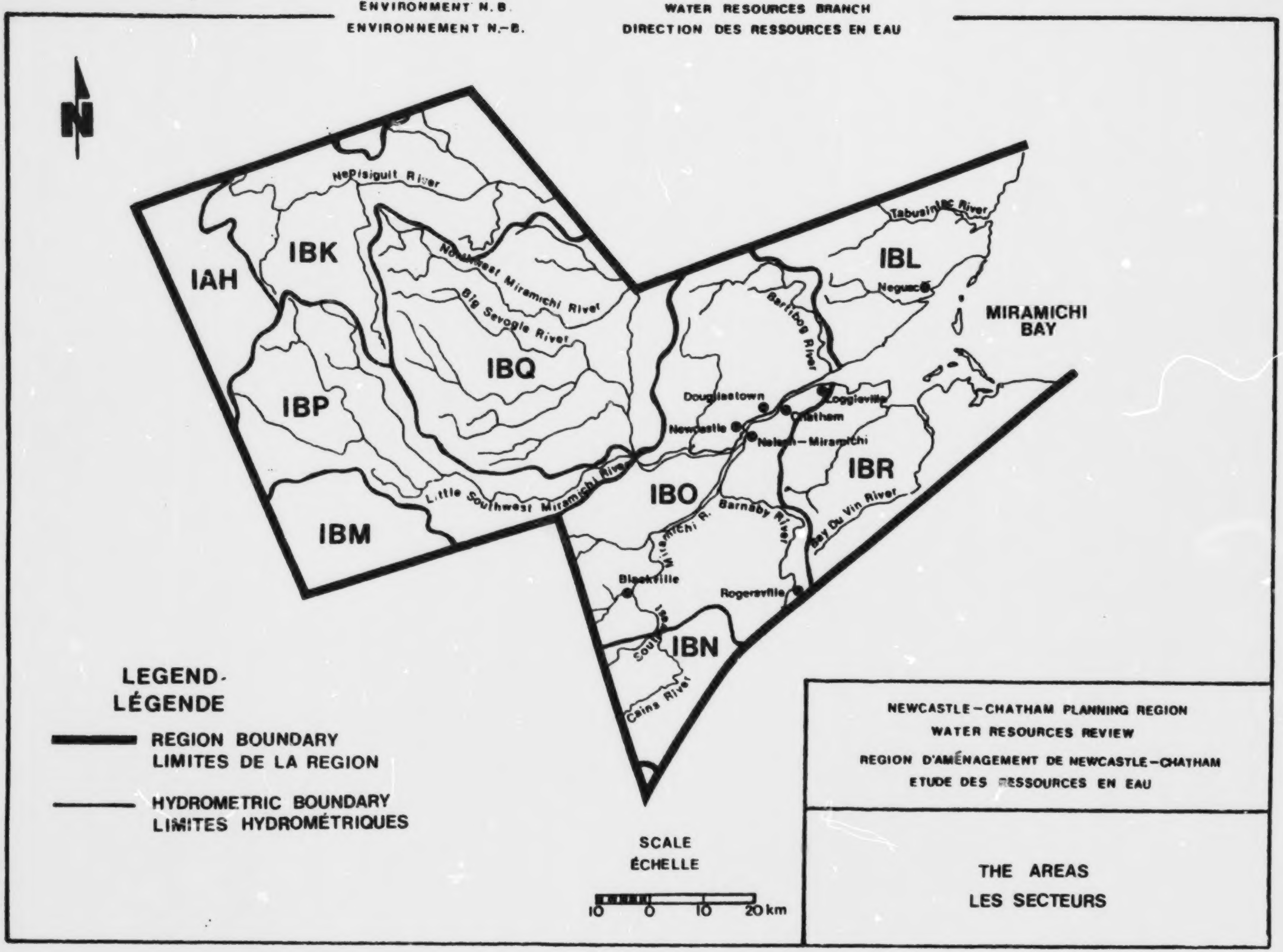

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.
WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU
N
IAH
IBK
IBP
IBM
IBQ
IBO
IBN
IBR
IBL
Nepisiguit River
Northwest Miramichi River
Big Sevogle River
Little Southwest Miramichi River
Bartibog River
Tabusintac River
Neguac
MIRAMICHI BAY
Douglastown
Newcastle
Chatham
Loggieville
Nelson-Miramichi
Miramichi R.
Barnaby River
Bay Du Vin River
Blackville
Rogersville
Cains River
LEGEND-
LÉGENDE
REGION BOUNDARY
LIMITES DE LA REGION
HYDROMETRIC BOUNDARY
LIMITES HYDROMÉTRIQUES
SCALE
ÉCHELLE
10 0 10 20 km
NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU
THE AREAS
LES SECTEURS

FIG. 2.1

River is considered to be a resource of the Bathurst Planning Region and it was entirely discussed in that review. (Department of the Environment, 1979). The Upper Nepisiguit area (1BK), that portion lying within the boundaries of Newcastle-Chatham Planning Region, will be discussed in this report. The portions of the drainage index subdivision 1BL and 1BR which lie within the planning region will be discussed under the area name of Miramichi Bay. The portions of the 1BL outside of the Newcastle-Chatham Planning Region were discussed in the Bathurst Planning Region Water Resources Review (New Brunswick Department of the Environment, 1979) and the Moncton Planning Region Water Resources Review (New Brunswick Department of the Environment, in press) respectively. The portions of 1BQ, 1BP and 1BO which lie outside the Newcastle-Chatham Planning Region do not represent significant water resources but are included in this area discussion. These three areas are discussed in their entirety. That portion of 1BN, the Miramichi Headwaters Area, which lies within the boundary of the Newcastle-Chatham Planning Region constitutes the lower half of Blackville Parish. To maintain consistency of the Water Resources Review report format and because this area contains major tributaries of the Miramichi River system, this portion of the area 1BN will be included in the Newcastle-Chatham report along with a review of the discussion found in the Fredericton Planning Region Review. (Department of the Environment, 1980).

For each of the six areas, a general discussion of the resources is provided covering location, population and water availability; a further section called "water use" includes comments on industrial, recreational and wildlife use, navigation, hydro-power, etc. In addition, any special problems such as flooding or specific management problems are discussed.

2.1.2. Water Availability

The mean annual precipitation in the Newcastle-Chatham Region is approximately 1097 mm. Runoff varies over the year, for a number of reasons of which precipitation, temperature, evapotranspiration and storage are the most important. High seasonal flows are generally experienced in April and May in most rivers within the planning region. Following the spring period, streamflows gradually decrease as the surface and groundwater storage is slowly depleted. This decrease usually continues throughout the summer months, particularly due to the high rate of evapotranspiration. A net increase in runoff is then experienced in the fall due to lower temperatures and the lower rate of evapotranspiration. In the winter months, most of the precipitation is stored within the snowpack; this phenomena is more pronounced on high ground within the region. As the majority of winter precipitation is captured in the snowpack, runoff is mainly derived from groundwater storage.

The mean annual values of various climatological and hydrometric parameters in the Newcastle-Chatham Planning Region are as follows:

Parameter	Mean Annual Value
Temperature (C^{o})	4.8
Total Snowfall (cm)	333.1*
Total Precipitation (mm)	1096.7
Runoff (mm)	584
Water loss (evapotranspiration mm)	380

* Snowfall varies from 250 cm (approximate) in the Bay area to 400 cm (approximate) in Northwest area.

The Miramichi River, with a total drainage of approximately 12,000 hectares (4,510 sq. mi.), is the largest river basin lying entirely within the Province of New Brunswick. It may conveniently be divided into the following major tributary watersheds: the Northwest Miramichi, the Sevogle, the Little Southwest Miramichi, the Dungarvon, the Renous, the Southwest Miramichi and the Cains River. The Miramichi River comprises the Northwest and Southwest branches which join some 26 km from its mouth which here is defined as the mouth of the Bartibog River. The western water divide of the Miramichi reaches a maximum elevation of 762 km. The western half of the Miramichi River Basin, in which the Miramichi Highlands are the dominant feature, is part of the New Brunswick Highlands. The eastern half is generally of relatively low relief and lies in the Gulf of St. Lawrence Plain. A list of the major rivers within the planning region is presented in Table (2.1).

The area of land occupied by large lakes in the Newcastle-Chatham region is small, amounting to about 0.32 percent of the total drainage area. Numerous small lakes are found in the New Brunswick Highlands and are the headwaters of many small tributary streams of the Little Southwest Miramichi in Southesk Parish. The most prominent lakes in the region include Grants Lake, Guagus Lake, Mullin Stream Lake and Tuadook Lake. Table (2.2) shows a list of lakes within the Newcastle-Chatham Planning Region.

A number of dams of various sizes have been constructed on watercourses within the planning region. Table (2.3) presents a list of these dams and identifies the active, inactive or breached status of each. This list was based on photo interpretive methods (Faig, 1980). The photographs used were those obtained in the period 1974 to 1976.

TABLE (2.1) TABLE OF MAJOR RIVER BASINS IN THE NEWCASTLE-CHATHAM REGION

RIVER NAME	DRAINAGE AREA Sq. Km.
Nepisiguit River	1,594
Burnt Church River	133
Tabusintac River	701
Cains River	1,533
Bartholomew River	361
Dungarvon River	573
Renous River	1,427
Barnaby River	494
S.W. Miramichi River	6,563
N.W. Miramichi River	2,510
Bartibog River	523
Miramichi River	12,303
Tomogonops River	160
Sevogle River	793
Napan River	114
Black River	279
Bay Du Vin River	289

TABLE (2.2) LIST OF LAKES IN THE NEWCASTLE-CHATHAM REGION

Lake	County	Parish	Area Sq.Km
Grants	Northumberland	Northesk	0.5
Guagus	Northumberland	Southesk	0.9
Holmes	Northumberland	Southesk	1.2
Island	Northumberland	Ludlow	0.2
Jacks	Northumberland	Southesk	1.4
Kennedy	Northumberland	Southesk	1.0
Logan	Northumberland	Southesk	0.8
Louis	Northumberland	Southesk	0.9
Mains	Northumberland	Southesk	0.8
McKendrick	Northumberland	Southesk	0.7
Mitchell	Northumberland	Southesk	1.2
Mullin Stream	Northumberland	Southesk	3.0
Muzroll	Northumberland	Northesk	0.6
North Little River	Northumberland	Northesk	1.3
North Renous	Northumberland	Southesk	1.5
South Little River	Northumberland	Northesk	0.5
Tuadook	Northumberland	Southesk	4.4

TABLE (2.3) LIST OF DAMS IN THE NEWCASTLE CHATHAM PLANNING REGION

Hydrometric No.	Name of Dam	Watercourse (Northumberland Co.)	Purpose of Dam	Dam Height (m)*	Type of Dam	Spillway Type	Status
BO 002	Picnic Site Dam	McGraw Brook	Recreation	3.0	Wooden	grated	active
BO 003		Oxford Brook					active
BO 004		Oxford Brook					active
BO 005	Fraser Mill Dam	Northwest Millstream	Water supply	4.3-4.9	Wood	Overflow	Breached
BO 006	Fish Hatchery Dam	Stewart Brook	Hatchery	3.0	Concrete	Gated	active
BO 007	Acadia Dam	Carding Mill Br.		3.0	Wood	Overflow	Breached
BO 008	White Rapids Bk Dam.	White Rapids Br.	Water Storage	4.9-5.5	Concrete	Overflow	active
BO 009	Monastery Dam	Burnaby River	Water Storage	2.4-3.0	Cribwork & rock	Overflow	active
BO 010	Blackville Mill Dam	Bartholomew River	Holding Pond	3.0-3.7	Wood	Overflow	Breached
BO 011		Chatham Reservoir					
BO 012		Unnamed					
BO 013		Unnamed					
BP 001		Tuadook River					
BQ 001		Little South Tomogonops water supply					
BQ 002	Heath Steele Dam	Br. of Tomogonops R.	Holding Pond	3.7	Earthfill	Gated	Breached
BQ 003	Northwest Miramichi Dam	Northwest Miramichi	Holding Pond	4.6	Wood	N.I.	Active
BQ 004		Mullin Stream					
BQ 005		Clearwater Stream					

*Converted to Metric
N.I. no Information

The New Brunswick Highlands division, occupying the northwestern half of the Planning Region, comprises pre-Carboniferous low to medium-grade metasediments and metavolcanics, intruded by Devonian granitic rocks. Little data is available from which to evaluate the hydrogeological characteristics of the largely uninhabited highland area. The sparse data agree closely with calculations made on this rock complex in the neighboring Fredericton Planning Region, where it was found that about 60-75% of wells drilled in pre-Carboniferous rocks yield 0.4 l/sec (5 gpm) or less and 25% or fewer of the wells yield between 0.8 and 2.0 l/sec (10 and 25 gpm). A significant proportion of wells drilled in this complex are probably in the order of 63 to 122 m (250 to 400 feet) deep, with low-yielding holes in particular being deeper in efforts to augment the supply or to create storage capacity. It is conceivable that moderately large groundwater yields could be found by careful exploration and drilling in fault zones and fracture zones along fold flexures.

The southeastern half of the Planning Region is underlain by nearly undisturbed red to grey sandstone, conglomerate, siltstone and shale of Pennsylvanian age. This sedimentary complex, having been deposited in an alluvial environment, is highly variable both horizontally and vertically, with abundant lenticular and channelized sedimentary structures.

The hydrogeological characteristics of the Pennsylvanian sedimentary complex are much different from those of the metasediments. Statistics from the planning region show that only 9.5% of all drilled wells yield less than 0.4 l/sec (5 gpm) and only a small fraction of 1% yield less than 0.15 l/sec (2 gpm). About 25-35% of wells have yields greater than 0.8 l/sec (10 gpm). Nearly 80% of all drilled wells in the Pennsylvanian sediments have depths of 27 m (90 ft) or less.

There are notable differences in depth and yield of wells in the upland areas and those in the valley areas within the Pennsylvanian sediments. Depth-frequency histograms in areas dominated by habitations along river valleys show the most frequently occurring concentrations to be in the 30 to 54 metre depth range. These modal concentrations, that is the most frequently occurring concentrations in the upland areas occur in about the 12 to 18 m depth range, indicating a greater likelihood of finding an adequate water supply at shallower depth in upland areas than in valleys.

Yield-frequency histograms for groups of wellsdrilled mainly in the river valleys show a strong modal frequency at 0.8 l/sec (10 gpm), with nearly 45% of all wells drilled in these areas yielding 0.6 to 0.8 l/sec (8 to 10 gpm). In the upland areas, the number of wells falling in unit increments between 0.4 to 0.8 l/sec (5 and 10 gpm) is fairly constant, with no pronounced modal point. About 70% of all wells are included in this group.

These differences in yield statistics are not a major concern in considering the ability of wells to provide household supplies, as any well yielding 0.15 l/sec (2 gpm) is exceedingly small. Wells in these Pennsylvanian sediments expressly constructed for municipal supplies, frequently yield up to about 15 l/sec (200 gpm) and in certain instances have yields much higher than this.

Surficial deposits throughout the region consist mainly of glacially-derived materials. The bulk of the area has a discontinuous cover of glacial till that is commonly up to 1 or 2 m thick and locally thicker. Gravel and sand deposits are fairly common occurring mainly at lower elevations. These include moderately thick but very localized ice contact stratified deposits and glacifluvial outwash and deltaic deposits frequently having somewhat greater extent. Alluvial gravels and sands are common along present watercourses, but these are frequently rather thin.

There exists in the lower Miramichi valley a sand and gravel aquifer, lying below present sea level and buried under a variable thickness of marine fine sediments. This is a freshwater bearing aquifer possibly largely recharged from bedrock where the two are in direct contact. The lower slopes of the valley walls of the Miramichi in the Newcastle-Chatham area are an important groundwater discharge zone. The granular aquifer is confined by the overlying fine sediments and possibly also by glacial till capping the bedrock on the lower slopes. This condition results in a piezometric surface about the surface level of the river, and gives rise to naturally flowing wells at low elevations. Groundwater from the granular aquifer probably discharges into the river or Miramichi Bay through breaks in the fine sediment confining layer in the area downstream from Chatham. The granular aquifer occupies an old bedrock paleo-channel of the Miramichi River, whose base lies at about 60 m (200 feet) below present river level. The top of the aquifer is encountered at depths ranging from about 12 to 40 m (39 feet to 130 feet) below river level.

The Town of Newcastle draws its water supply largely from this granular aquifer. At least four of the six operational town wells are developed in gravel. Pumping rates on the gravel wells range between approximately 19 and 38 l/sec (250 and 500 gpm). Wells that are advantageously sited and are constructed and developed for optimum performance might have substantially greater yields than this.

Exploration for and evaluation of this aquifer in the vicinity of Chatham might provide an alternative to using the bedrock water source with its associated problems.

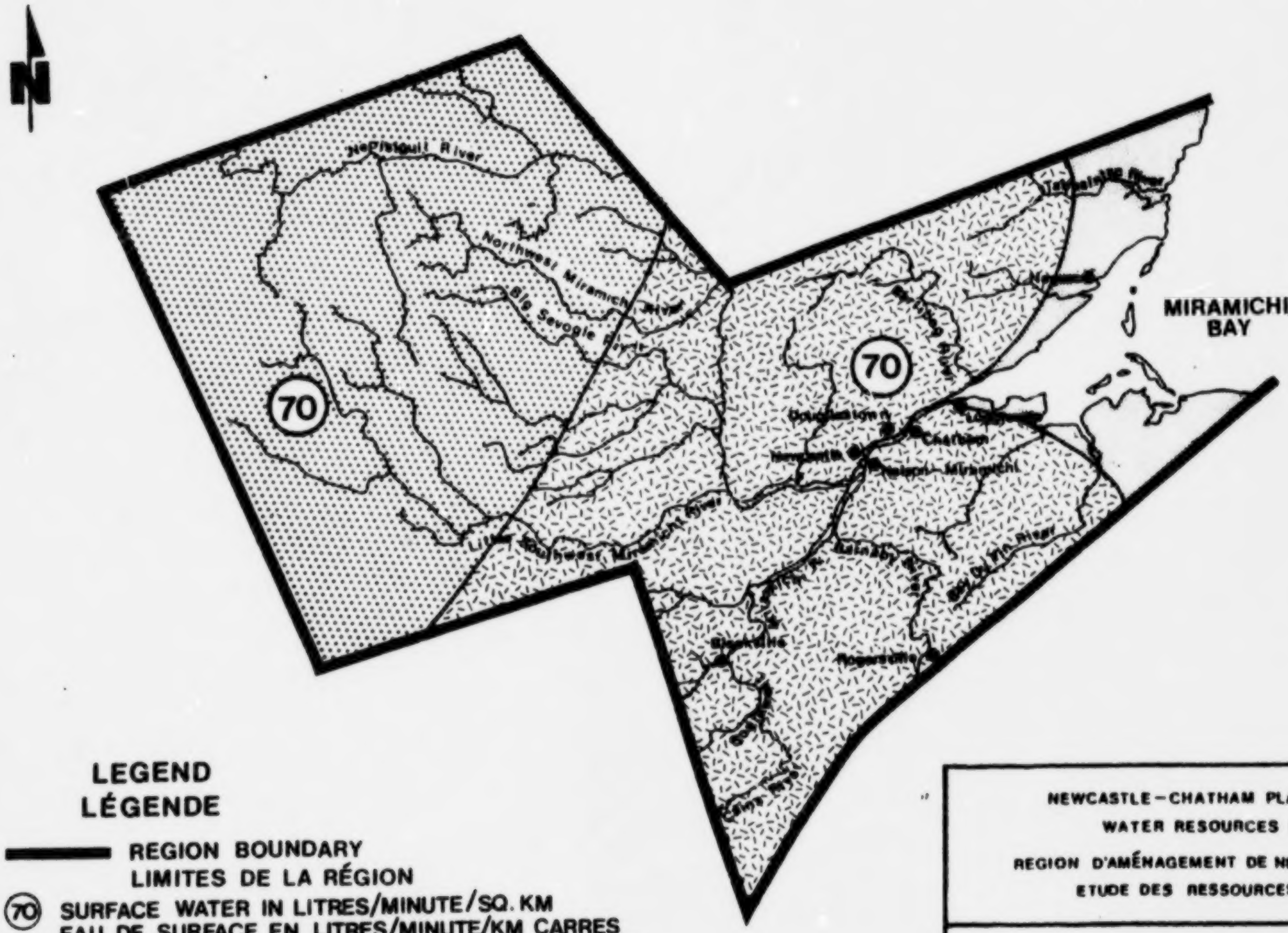
Upstream from the vicinity of Renous and Quarryville, the southwest Miramichi River has alluvial terraces composed of sand and gravel, that might provide a source of substantial quantities of water.

A simplified map indicating the available surface and groundwater resources in the planning region is shown in Figure 2.2. The surface water information was based on the available low flow frequency analysis (20 year period, 7 day duration low flow) at various hydrometric stations. The available yield from a particular watercourse in litres per second can be obtained by multiplying the area of the drainage basin in square kilometres by the number shown on the map. The groundwater information presented in this figure was based on the available well records within the region. This information indicates the approximate expected yield in litres per second from wells drilled in various areas.

A "Water Availability Map", based on the above analysis, covering the entire province is available from the Water Resources Branch, New Brunswick Department of the Environment.

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
Nepisiguit River
Northwest Miramichi River
Big Sevogle River
Little Southwest Miramichi River
70
70
Tabusintac River
Neguac
Bartibog River
MIRAMICHI
BAY
Douglastown
Chatham
Loggieville
Newcastle
Nelson-Miramichi
Barnaby River
Bay du Vin River
Blackville
Rogersville

LEGEND
LÉGENDE

━ REGION BOUNDARY
LIMITES DE LA RÉGION

⑦⓪ SURFACE WATER IN LITRES/MINUTE/SQ. KM
EAU DE SURFACE EN LITRES/MINUTE/KM CARRES

▒ AVERAGE WELL YIELDS LESS THAN 50 LITRES/MINUTE
PRODUCTION MOYENNE DE MOINS DE 50 LITRES/MINUTE

▨ AVERAGE WELL YIELDS 50-250 LITRES/MINUTE
PRODUCTION MOYENNE DE 50 À 250 LITRES/MINUTE

☐ AVERAGE WELL GREATER THAN 250 LITRES/MINUTE
PRODUCTION MOYENNE DE PLUS DE 250 LITRES/MINUTE

SCALE
ÉCHELLE

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

AVAILABLE WATER RESOURCES
RESSOURCES EN EAU DISPONIBLES

FIG. 2.2

2.1.2.1

Response of Well Water Levels to Earthquakes, Winter 1982

During the winter and early spring of 1982, a number of earthquakes of moderate magnitude occurred in the north-central part of New Brunswick. The first and largest of the shocks occurred at 8:53 a.m. on 9 January 1982 and had a Richter Scale Magnitude of 5.7. During the early part of February, New Brunswick Dept. of the Environment began receiving reports of water wells going dry, largely in the area northwards and eastwards from Newcastle. Many people attributed this occurrence to the earthquakes. The phenomenon evidently was restricted to wells drilled in the Carboniferous sedimentary complex with no occurrences known in pre-Carboniferous rocks.

The Department of the Environment, Water Resources Branch, conducted a review of water level behaviour in several observation wells in the area through this period and also reviewed weather conditions. Weather data from Chatham indicated that while the winter of 1982 had roughly average total precipitation, temperatures were consistently cold, so that very little of the precipitation was in the form of rain and no water was liberated by snow melt for a period of over 2½ months. It was concluded that there had been no recharge of the groundwater system between late December 1981 and early-to mid-March 1982. This probably resulted in the establishment of a "hydrologic drought" during this period. In contrast, it has been common in previous years during the January-February period to have a significant midwinter thaw, often accompanied by rainfall.

Most observation wells had shown a declining water level trend for about 3 weeks before the 9 January earthquake. Three wells including one at Allardville and two at Chatham showed marked downward responses to the first earthquake shock ranging between about 0.33 and 1.1 m(1.1 and 3.5 feet) in the first 2 days after the shock. A fourth observation well located at Chatham showed a rapid water level rise of about 0.4 metres(16 inches) by 11 January and a subsequent reestablishment of a declining water level trend by 16 January. Considered together,the graphs of all these water level changes indicate a temporary effect on groundwater levels by the first earthquake and that the duration of this effect was about 7 days with most of the response coming in the first 2 days after the shock. No such equivalent to the one on 9 January.

The response of well water levels in opposite directions at different locations suggests that the causative mechanism may be the movement of large bedrock blocks relative to one another. In this process, minute movements of the rock blocks would cause opening of some inter-block fractures and concurrent narrowing of fractures at other locations. Water level in a fracture that is suddenly widened would obviously drop, while the opposite water-level response would occur in a fracture that is narrowed. The observed differential response of observationwell levels after the 9 January tremor appears to be consistent with this mechanism. In most cases the response is evident only after the initial tremor on 9 January probably because this tremor settled the crustal blocks into stable positions and also possibly because this was the largest of the shocks.

Because the process is not known to involve any significant loss of water from the formation, but only local changes in hydraulic head, the water would tend to seek an equilibrium level after the event has passed, with the water redistributing itself through interconnected fractures. This explains the temporary nature of the water level changes. In fact, there were probably at least as many private wells that experienced water level increases as those that showed declines, but increased levels would go unnoticed except in vary rare cases where overflows result. One such case was noted in Newcastle, involving an abandoned well. In addition, the pumping level in the Town of Newcastle's Mitchell St. #2 well was noted shortly after the earthquake to be about 4.5 m (15 feet) above normal.

It is worth noting here that all the available water level data are from relatively deep observation wells tapping semi-confined water sources. There is no direct recorded evidence of water level behaviour in any shallow, perched-aquifer wells that would be typical of many of the private wells that have experienced problems. It is impossible even to establish whether or not there actually was any instantaneous level response in any of the shallow wells similar to the phenomenon noted in the observation wells.

Reliable depth figures on about half of the over 200 reported dry wells indicate that about 75% are less than 23 metres (75 feet) deep and over 60% are between 3 and 17 metres (10 and 55 feet) deep, compared to an average depth of 35 metres (115 feet) for all recorded wells in the province. Shallow groundwater in the Pennsylvanian rocks likely occurs as perched water tables in the fractured rock, held up by semi-impermeable shale interbeds. Water levels in such systems would be exceptionally vulnerable under low recharge conditions, being subject to depletion both by water extraction through wells and also by downward leakage through the same aquitard.

Much of the data on "dry wells" actually stems from wells that were reported to have stopped yielding water, with "dryness" in many cases being equated with a simple condition of low water level. Pumping drawdown from a lowered static water level might cause loss of prime in the pump. In several known cases, the problem was solved simply by adding a few extra feet of pipe and lowering the footvalve to keep it in the water.

In only 5% of the reported dry well cases did the problem occur in the 5 day period immediately following the 9 January earthquake. The median date for the "drying up" event for all cases where dates were quoted was 5 February, that is, half of the problems started before that date and the other half started on or after that date. The largest number of reported dates for wells drying up in any of the consecutive 5-day period following 9 January was in the period 1-4 February, about 3½ weeks after the first earthquake.

Considering the broad temporal distribution of the data on the "drying up" event in the various wells, it is difficult to attribute this phenomenon totally or even largely to the 9 January earthquake; despite the fact that the tremor obviously had a short-term effect on observation well levels. The most plausible explanation for the phenomenon is that, given the severe winter weather conditions, most of the problem wells would likely have behaved similarly in the absence of seismic activity. The cumulative result of the earthquake effect added to the winter drought effect may have triggered the problem in a fraction of the cases and may also have promoted the onset of the dry well phenomenon at a somewhat earlier date that would otherwise have prevailed. It is felt, however, than the major causative factor behind the dry well phenomenon is the long-term lack of recharge.

During the first week of April, 1982, reports began appearing in the newspapers of dry wells recovering their water supply. Initial reporting seemed to indicate that this had occurred in response to the Richter 4.8 earthquake that occurred on 30 March. To investigate this possibility, the Groundwater Section conducted a telephone survey of 23 of the documented problem households (10% of the reported total) in various parts of the Northeastern Peninsula. It was determined that 15 of these wells (65%) had started producing water again by 15 April. The great majority had recovered between 13 and 30 March, before the occurrence of the 30 March tremor. It is clear that the wells did not recover as a result of the earthquake but because of normal spring recharge effects.

2.1.3 Water Quality

2.1.3.1 Surface Water Quality

With the exception of the upper reaches of the Southwest Miramichi and the Cains Rivers, almost all of the Miramichi and seventy (70%) percent of the Nepisiguit watersheds lie within the boundaries of the Newcastle-Chatham Planning Region. The surface water of both systems are predominately riverine. Lakes comprise approximately 0.21 percent of the Miramichi drainage basin and 0.27 percent of the Nepisiguit River drainage basin.

The majority of the lakes are found in the northern half of Northesk and Southesk Parishes in Northumberland County and there are very few larger than 40 hectares. The larger and more studied of the two watersheds is the Miramichi River system, long prized and internationally known for its salmonid fishing. This river basin consists of a large network of freshwater tributaries which flow in a generally easterly direction into a saltwater estuary.

A variety of water quality-related surveys have been carried out by the Department of the Environment within the past two decades in the Newcastle-Chatham region. While a wider range of tests is now included in surveys, there appears to be no apparent degradation in general water quality when results of surveys conducted during the summers of 1981 and 1982 are compared with results of a 1964 survey of the same sample locations.

Tables (2.4), (2.5), (2.6) contain a listing of sample locations on watercourses located within the boundaries of the planning region. Both provincial and federal data are included.

The results of the chemical analyses of these samples indicate that the waters of the Miramichi River system are generally very soft and lightly coloured with a pH fluctuating around neutral levels. Nutrient concentrations (levels of carbon, phosphorus, nitrogen) usually remain low, as do heavy metals and dissolved solid concentrations. The buffering capacity (water's ability to neutralize incoming acids) of the surface waters of the region is low.

In August 1981 a water quality survey was conducted by the Department of the Environment assessing the effect of industrial and municipal effluents on dissolved oxygen levels in the Miramichi River in the Newcastle area.

TABLE (2.4) MEDIAN NUTRIENTS LEVELS - NEWCASTLE-CHATHAM PLANNING REGION*

Station		Watercourse	Total Organic Carbon (mg/1)	Total Kjeldahl Nitrogen (mg/1)	Nitrate Nitrite (mg/1)	Total Inorganic Phosphate (mg/1)	Total Phosphate (mg/1)
00NB01BO	0001	Miramichi River @Blackville	6.9	< .5	.019	.003	.010
00NB01BN	0001	Cains River @Mouth	11.0	.4	.016	.02	.013
00NB01BO	0007	Barnaby River@Barnaby River	9.5	< .5	.056	.025	.030
00NB01BO	0019	Bartibog River @Hwy 8	5.8	< .5	.030	.017	.006
00NB01BO	0002	Renous River near McGraw Brook					
00NB01BP	0001	Little Southwest@ Lyttleton	5.8	1.1	.020	.010	.010
00NB01BQ	0001	Northwest Miramichi @RedBank	5.8		.038	.020	< .0005
00NB01BQ	0004	South Tomogonops@Hwy 430					
00NB01BO	0008	Sevogle River@mouth	6.1	< .5	.090	0.15	.005
00NB01BQ	0013	Little South Tomogonops (Above mine)					
00NB01BQ	0017	(Below mine)					
00NB01BQ	0018	Tomogonops River-mouth					
00NB01BQ	0019	Northwest Miramichi (about tomogonops)					
00NB01BQ	0029	South Sevogle River (above Clearwater Stream)					
00NB01BO	0031	South Sevogle River (below Sheephouse Bk)					
00NB01BQ	0044	Northwest Miramichi (Wayterton)					
00NB01BQ	0053	Northwest Miramichi@ Curbenton					
00NB01BQ	0056	Northwest Miramichi@ Hwy 430	3.4		.085	< .005	.005
00NB01BQ	0035	Northwest Miramichi@ Payne					

*Federal Stations
Source: Environment Canada, 1979 Water Quality Data New Brunswick, 1961-1977

TABLE (2.4) MEDIAN NUTRIENT LEVELS NEWCASTLE-CHATHAM PLANNING REGION*

Station		Watercourse	Total Organic Carbon (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Nitrate Nitrite (mg/l)	Total Inorganic Phosphate (mg/l)	Total Phosphate (mg/l)
00BR01BO	0004	Miramichi R. @Chatham	9.3	.4	.11		.165
00BR01BO	0005	Miramichi R.@Newcastle	6.1	.5	.035		.195
00BR01BO	0007	Miramichi R. @Quarryville	6.3	.25	<.01		.085
00BR01BO	0008	Renous River @Mouth	5.9	.25	<.01		.095
00BR01BO	0009	Dungarvon River @ Pineville	6.0	.3	<.01		.080
00BR01BO	0010	Bartholomeu River@mouth	7.6	.3	<.01		.100
00BR01BP	0001	Little Southwest Miramichi	5.4	.25	.01		.065
00BR01BQ	0011	Northwest Miramichi @Exmoor	5.4	.3	.05		.135
00BR01BN	0001	Cains River near mouth	10.1	.3	<.01		.05
00BR01BN	0002	Miramichi R.@Upper Blackville	5.6	.3	.07		.05
00BR01BK	0001	Nepisiquit Lake	2.0	.2	<.01		.08
00BR01BK	0002	Nepisiquit Lake	2.2	.29	<.01		.06
00BR01BK	0003	Nepisiquit Lake	1.8	.2	<.01		.05
00BR01BK	0004	Nepisiquit Lake	2.0	.2	.01		.06

*Provincial Data

Source: Environmental Services Branch. Environment New Brunswick

TABLE (2.5) MEDIAN HEAVY METALS CONCENTRATION: NEWCASTLE-CHATHAM PLANNING REGION*

Station		Watercourse	Cadmium (mg/1)	Copper (mg/1)	Iron (mg/1)	Lead (mg/1)	Mercury (mg/1)	Zinc (mg/1)
OONB01BO	0001	Miramichi River@Blackville	<.001	< .01	.130	.004	< .00005	.010
BN	0001	Cains River@mouth	<.001	.002	.210	.002	< .00005	.006
BO	0007	Barnaby River@Barnaby River	<.001	.002	.480	.002	< .00005	.012
	0019	Bartibos River @Hwy 8	<.001	< .002	.190	.002	< .00005	.007
	0002	Renous River near McGraw Brook	<.001	.004	.135	.002	< .00005	<.010
BP	0001	Little Southwest@ Lyttleton	<.001	< .010	.105	002	< .00005	<.010
BQ	0001	Northwest Miramichi-Redbank	<.001	.010	.150	.002	< .00005	.040
BQ	0004	South Tomogonops@Hwy430	.001	.01	.395	.016	.00023	.093
	0008	Sevogle River-mouth	.001	.001	.155	.002	< .00005	.005
	0013	Little South Tomogonops (above mine)	.001	.010	.250	.007	.0001	.015
	0017	Little South Tomogonops (below mine)	.002	.310	1.100	.016	< .00005	3.300
	0018	Tomogonops River-mouth	.001	.040	.160	.006	.00005	.515
	0019	Northwest Miramichi (above Tomogonops)	<.001	< .01	.110	.005	.00005	<.01
	0029	South Sevogle River (above Clearwater Stream)	<.001	< .010	.160	.002	.00005	<.010
	0031	South Sevogle River (below Sheephouse Bk.)	<.001	< .010	.175	.005	.00007	.010
	0044	Northwest Miramichi @Wayerton	<.001	.005	.170	.005	< .00005	.04
	0053	Northwest Miramichi @Curventon	<.001	.002	.140	.004		.04
	0056	Northwest Miramichi @Hwy 430	<.001	< .002	.075	< .002	< .00005	.002

*Federal Data

(Continued)

TABLE (2.5) MEDIAN HEAVY METAL CONCENTRATIONS: NEWCASTLE-CHATHAM PLANNING REGION*

Station		Watercourse	Cadmium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Zinc (mg/l)
00NB01B0	0035	Northwest Miramichi @Payne	.001	.004	.130	.005		.010
00B01BK	0017	Nepisiquit River	< .001	.005	.080	.005	.00005	.020
	0032	Nepisiquit River	< .001	.003	.110	.004	.00005	.003
	0035	Nepisiquit River	< .001	< .002	.080	.004	.00005	.008

*Federal Stations

Source: Environment Canada, IWD, Water Quality Branch, Water Quality Data N.B. 1961-1977, Ottawa, 1979

Table (2.6)
Physical Parameters - Newcastle-Chatham Planning Region

STATION	WATER COURSE	TOTAL HARDNESS	SUSPENDED SOLIDS	pH	DISSOLVED OXYGEN (mg/l)	SPECIFIC CONDUCTANCE (us/cm)	CHLOROPHYLL (mg/l)	SECCHI DEPTH (m)	FECAL COLIFORM NUMBER/100 ml
00BR01B00004	Miramichi@Chatham	1170	7200	7.2	*	10500	C	C	125
00BR01B00005	Miramichi@Newcastle	130-1500		7.0	*		C	C	435
00BR01B00007	Miramichi@Quarryville	11.5	36.	7.0	*	37	C	C	102
00BR01B00008	Mouth of Renous R.	15.0	40	7.0	*	33	C	C	155
00BR01B00009	Mouth Dungarvon R.	14.0	19	7.2	*	32	C	C	80
00BR01B00010	Mouth Bartholomew R.	16.7	34	7.2	*	41	C	C	100
00BR01BP0001	Little Southwest	9.7	26	6.9	*	27	C	C	38
00BR01BQ0011	Northwest@Exmoor	19.5	32	6.9	*	45	C	C	450
00BR01BN0001	Cains River	14.0	38	6.9	*	36	C	C	45
00BR01BN0002	Upper Blackville	13.2	24	6.9		37	C	C	70
01BR01BK0001	Nepisiquit Lake*	15		6.8			.0034	2.0	0
01BR01BK0002	Nepisiquit Lake	14		6.8			.0020	2.0	0
01BR01BK0003	Nepisiquit Lake	14		6.9			.0024	2.0	0
01BR01BK0004	Nepisiquit Lake	13		6.8			.0013	2.0	0
				Federal	Stations				
00NB01BK0017	Nepisiquit River	14.5		7.0	9.2	37			
00BR01BK0032	Nepisiquit River	14.9		7.0	9.5	39			
00BR01BK0035	Nepisiquit River	15.6		7.1	9.4	39			
00NB01B00001	Miramichi River@ Blackville	14.8	14.9	6.8	11.5	39			
00NB01BN0001	Cains River@Mouth	15.4	24	6.6	10.8	41			
00NB01B00007	Barnaby River@ Barnaby River	16.3	25	6.5	11.8	44			
00NB01B00019	Baribog River@Hwy 8	28.6	37	7.1	12.0	66			
00NB01B00002	Renous River near McGraw Bk.								
00NB01BP0001	Little Southwest@ Lyttleton	11.5	17	6.8	11.9	31			
00NB01BQ0001	Northwest Miramichi @Redbank	19.0	27	6.8	11.8	50			

*Parameters for Nepisiquit reported as medians
C - Lake Parameters

Table (2.6) Continued

Physical Parametres - Newcastle-Chatham Planning Region

STATION	WATER COURSE	TOTAL HARDNESS	SUSPENDED SOLIDS	pH	DISSOLVED OXYGEN (mg/l)	SPECIFIC CONDUCTANCE (us/cm)	CHLOROPHYLL (mg/l)	SECCHI DEPTH (m)	FECAL COLIFORM NUMBER/100 ml
00NB01BQ0004	South Tomogonops @ Hwy 430	408.0		7.2		698			
00NB01BQ0008	Sevogle River-mouth	12.0	18	6.5	13.2	31			
00NB01BQ0013	Little South Tomogonops(above mine)	8.8		6.5		26			
00NB01BQ0017	Little South Tomogonops (below mine)	33.6		5.0	8.7	139			
00NB01BQ0018	Tomogonops River-mouth	89.8		6.9	8.5	181			
00NB01BQ0019	Northwest Miramichi-(above Tomogonops)	18.2		7.1	8.6	47			
00NB01BQ0029	South Sevogle River Above Clearwater St.	12.0		7.0		34			
00NB01BQ0031	South Sevogle River below Sheephouse Br.	12.2		7.1		39			
00NB01BQ0044	Northwest Miramichi @Wayerton	30.5		6.9	8.4	79			
00NB01BQ0053	Northwest Miramichi @Curveton	27.4		6.8		76			
00NB01BQ0056	Northwest Miramichi @Hwy 430	15.9	26	6.8	10.0	39			
00NB01BQ0035	Northwest Miramichi @Payne	16.4		7.1		41			

C - Lake Parametres

Source: a)Environmental Services Branch, N.B. Dept. of the Environment
b)Environment Canada, IWD Water Quality Branch, "Water Quality Data-NB 1961-1977, Ottawa,

Measurements taken of a series of river profiles showed dissolved oxygen concentrations to be at levels inhabitable by fish. Although reduced below saturation levels, dissolved oxygen-temperature relationships showed no evidence of stress at other sampling points in the region.

Results of monthly sampling conducted during the summers of 1981 and 1982 showed sporadically higher concentrations of aluminum at the Chatham and Newcastle stations than is recommended for the long-term protection of aquatic biota, but the levels, however, remained below those thought to be acutely toxic to these lifeforms. Aluminum concentrations at Exmoor on the Northwest Miramichi River were also occasionally elevated. Aluminum sulphate is a constituent of pulpmill effluents in the Newcastle area and aluminum is present in the effluent of the Heath Steel mining operation which discharges treated effluent to the Northwest Miramichi River via the Tomogonops River.

Relatively high fecal coliform bacteria densities at several sampling points were also indicated. Fecal coliforms are bacteria found in the intestinal tract of warm-blooded animals, including man. They are used as indicators of the degree of pollution by domestic waste. High fecal counts at the Chatham and Newcastle sampling points suggest that the Miramichi River is receiving untreated or unsatisfactorily treated domestic waste in making the areas frequently unsuitable for direct contact recreational use. Coliform counts occasionally exceeded recommended limits at Exmoor on the Northwest Miramichi River and at the mouth of the Renous River. This indicates a need for improved waste treatment.

The concentrations of fecal coliform in samples taken at stations on the Bartholomew, Cains, Dungarvon, Little Southwest and Main Southwest Miramichi Rivers indicate the presence of some domestic waste. These concentrations, while indicating the presence of some waste, remain within the range of values recommended for direct contact recreation. These levels probably resulted from inadequate or improperly operated individual waste systems with outflows which drain directly or indirectly into the watercourses.

The portion of the Nepisiguit River drainage lying within the Newcastle-Chatham Planning Region contains the largest lake in the region, Bathurst Lake. Results of sampling conducted during the summer of 1975 and the winter of 1976 showed the lake water to be of high recreational quality and moderately sensitive to acid input. The monitoring of the water quality of the Nepisiguit River system has been less frequent than in the Miramichi region. Sampling has been generally restricted to areas around mining developments.

Currently, the only water quality-related concerns on the Nepisiguit River are associated with the discharge of mining effluents. While heavy metal concentrations were generally low in the Nepisiguit River, occasionally concentrations above recommended levels have occurred. That reach of the Nepisiguit River flowing within the Newcastle-Chatham Planning Region receives discharges from the Anaconda mining operation via Forty Mile Brook. For a time, Forty Mile Brook also received additional mine discharges from the Wedge Mine. This operation closed in 1968. The periodic leakage of contaminated mine water from the abandoned site in the 1970's necessitated the sealing of mine shafts. Landscaping of the mined area in 1977 was done to stop leaching of mine tailing into the brook. A portion of Forty Mile Brook remains contaminated by mine discharge from the Anaconda Mine during its time of operation. For this reason, the Nepisiguit River which has an estimated annual potential run of 30,000 adult salmon, is slated for an enhancement and restoration program by Fisheries and Oceans Canada. Environment New Brunswick plans to survey the Nepisiguit River in the near future.

2.1.3.2. Groundwater Quality

In the gravel aquifer at Newcastle, hardness of the water is moderate, in the order of 80 to 90 mg/l and pH is on the alkaline side of neutral, about 7.8 or 7.9 from most of the wells. Chloride content is low. The only chemical characteristic of water quality that might cause any problem is the content of manganese, which commonly tests at about 0.05 mg/l. The standard is set for aesthetic reasons and manganese content at or above approximately 0.2 mg/l may begin to cause minor staining of plumbing fixtures and light-coloured fabrics in washing and possibly a minor metallic taste. Manganese content of the mixed water in the Newcastle system probably only exceeds this concentration on infrequent occasions.

Wells drilled in the Pennsylvanian bedrock typically produce one of two types of water. Wells of moderate depth with relatively short casing, are supplied mainly by water from the shallow unconfined fractured zone lying above the first aquitard. The water usually exhibits a pH that is near or slightly on the acid side of neutral, this characteristic being the result of the acidity of precipitation water which is the main source of the recently-recharged shallow groundwater. These waters are normally moderately hard to very hard as a result of solution of calcium carbonate cement from the formation by the bicarbonate waters. The acidity of percolating water also commonly results in high concentrations of manganese and iron dissolved from the rock or peat deposits. This water usually contains sodium and chloride ions only in low concentrations.

The second major water type is encountered by wells that draw all or most of their water from below the first significant shale or mudstone aquitard and is most noticeable in wells with fairly deep casing, seated in the aquitard and excluding inflow of the shallow groundwater. During percolation to this greater depth and possibly lateral movement under confined conditions in the lower aquifer zone, the water is apparently subjected to a natural base-exchange softening process whereby it takes on sodium ions from the formation and leaves calcium ions in their place. The result is a water of much decreased hardness, but frequently moderately elevated sodium content, that can be classified as a sodium bicarbonate water, or in the early phase of the transition as sodium-calcium bicarbonate water. At the same time, chloride content is low. As establishment of the sodium bicarbonate characteristic proceeds, pH increases and may reach a level of 9 or greater in water exclusively from deep zones. The now-basic pH evidently causes precipitation of dissolved iron and manganese, which are typified by relatively low concentrations in this water.

Elevated chloride content is not a natural property of the groundwater, but originates either from infiltration of water contaminated with road salt, or from intrusion of salt water from the Miramichi estuary in response to upsets of the natural hydraulic gradient by overpumping of wells.

The chemical quality of water supplies in selected municipalities within the Newcastle-Chatham Planning Region is presented in Table (2.7).

TABLE (2.7) GROUNDWATER QUALITY OF SELECTED COMMUNITIES IN THE NEWCASTLE-CHATHAM PLANNING REGION

COMMUNITY	TURBIDITY NTU	CONDUCTANCE	pH	ALKALINITY mg/1	CHLORIDE mg/1	NITRATE & NITRITE mg/1	FLOURIDE mg/1	HARDNESS mg/1	MAGNESIUM mg/1	CALCIUM mg/1	SULPHATE mg/1	SODIUM mg/1	POTASSIUM mg/1	MANGANESE mg/1	IRON mg/1
Chatham	.19	860.	7.6	106.	*330.	L .01	L.1	*251.527	15.	76.	24.	58.	2.7	*.55	L.05
Douglastown	L.1	200.	7.87	86.	L5.	.02	L.1	80.208	2.5	28.	7.6	6.0	.73	.04	L.05
Newcastle	.05	400.	7.9	100.	37.	L.01	L.10	94.725	3.6	32.	25.	35.	1.2	*.22	L.05
Maximum Acceptable Limits	.5	-	6.5 to 8.5	-	250	10.	1.5	-	-	-	500	-	-	0.05	0.3

Based on Distribution System Samples Taken, Summer 1982.

*Exceeds limites set by Guidelines for Canadian Drinking Water Quality, 1978

2.2 The Upper Nepisiguit Area

2.2.1 General Discussion - Upper Nepisiguit Area

Except for specific references to the Upper Nepisiguit River, the following is extracted from the Bathurst Planning Region Water Resources Review (New Brunswick Department of the Environment, 1979) and refers to the entire Nepisiguit River Basin.

The Nepisiguit River Basin lies within three planning regions: the Campbellton-Dalhousie Planning Region, the Newcastle-Chatham Planning Region and the Bathurst Planning Region. Although 70 percent of the basin is within the Newcastle-Chatham Planning Region, the water resources of the Nepisiguit River with its outlet into Bathurst Harbour, should be considered a resource primarily of the Bathurst Planning Region. The Nepisiguit River flows easterly through the Miramichi Highlands and then shifts to a northerly direction through the New Brunswick Lowlands to its outlet in Bathurst Harbour.

The Nepisiguit River Basin stretches across the middle of the upper half of the Province of New Brunswick. It is bordered on the north by the drainage basins of the Tetagouche, Middle, Little and Upsalquitch Rivers; on the west by the Tobique River Basin; on the south by the Miramichi River Basin and on the east by the Bass River Basin.

The major part of the Upper Nepisiguit Area (drainage index subdivision 1BK) is contained within the Parish of Northesk in the County of Northumberland. Small portions of the area lie outside the planning region in the Parishes of Addington, Balmoral and Colborn in Restigouche County. These areas do not represent significant water resources and no industry or settlement is located here. A map of the Nepisiguit Area is presented in Figure (2.3).

The Nepisiguit River Basin has a drainage area of 2,330 km^2 and is approximately 160 km long. It is the province's fourth largest basin with an outlet to the sea. Table (G.1)contains information on the Nepisiguit River Basin. Although some of the tributaries of the Saint John River drain larger areas, the Nepisiguit River Basin is the second largest to lie entirely within the boundaries of New Brunswick. The average elevation of the Nepisiguit River Basin is 338 m. It extends out of the planning region to a source in the Miramichi Highlands close to Mount Carleton.

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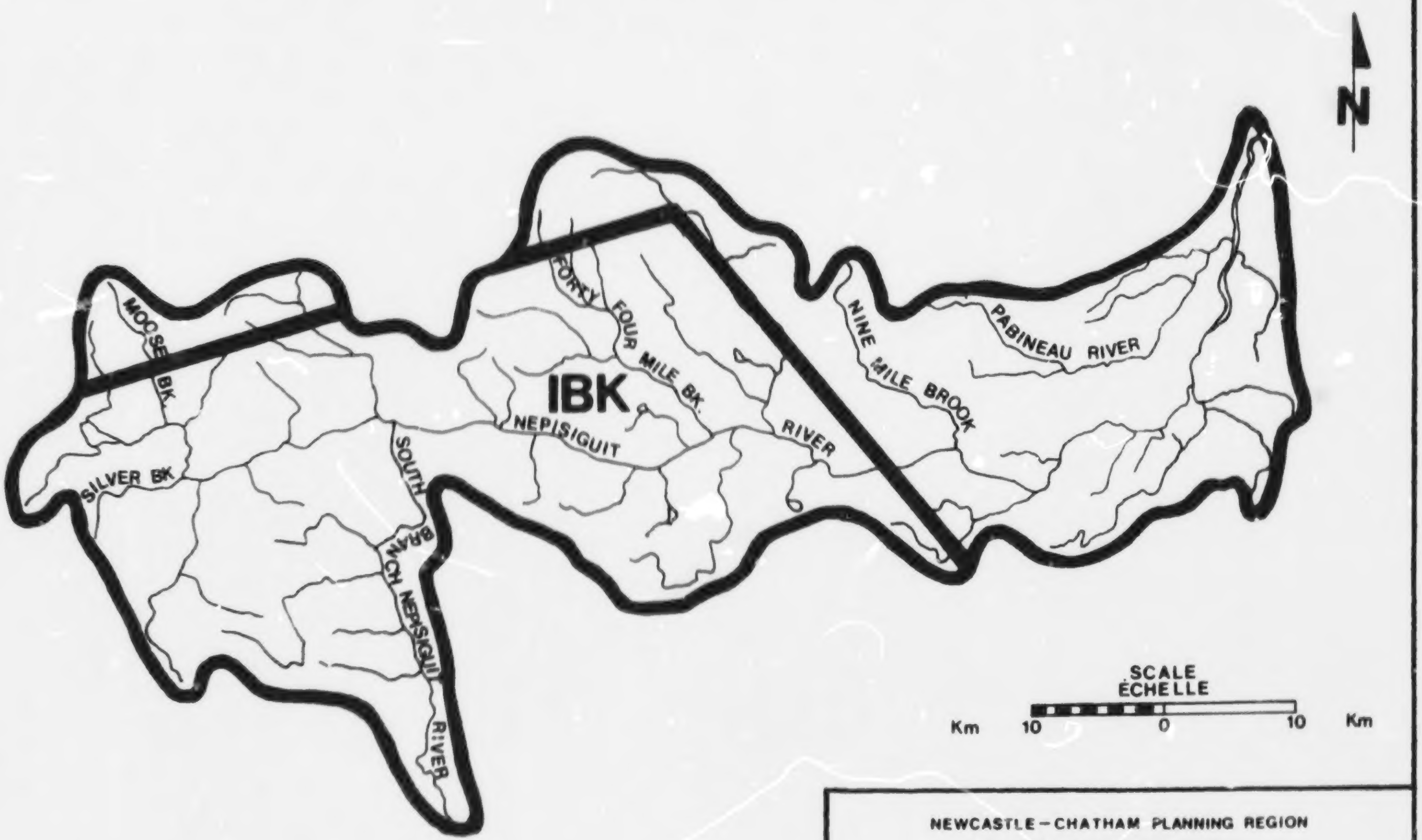
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MOOSE BK.
SILVER BK.
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NEPISIGUIT RIVER
NINE MILE BROOK
PABINEAU RIVER
SCALE
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LEGEND
LÉGENDE

▬ REGION BOUNDARY
LIMITES DE LA RÉGION
▬ HYDROMETRIC BOUNDARY
LIMITES HYDROMETRIQUES

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WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

UPPER NEPISIGUIT AREA
IBK
SECTEUR NEPISIGUIT

FIG. 2.3

The total area of lakes and swamps in the Nepisiguit River Basin is 0.4 percent of the drainage area. The associated watercourses drain about 15 percent of the drainage area of the basin. Almost the entire basin is forested. A listing of the major watercourses within the Newcastle-Chatham Planning Region is found in Table (2.1).

The New Brunswick Lowlands are characterized by a very low relief which becomes a featureless coastal plain at the eastern end of the peninisula. Flat lying continental sedimentary rocks of Pennsylvanian Age give this area its characteristic physiography. The surficial geology of the lowlands is typically shallow deposits of ablation till. These may be deeper in the present river valleys and in any ancient river valleys that may be present. In the eastern part of the peninsula, peat bogs and salt marshes are common. Beach-bar complexes are a typical feature of the southern coast of the Peninsular Area.

The Nepisiguit Highland Area has relief rising steadily to the highest point in the planning region of approximately 360 m above sea level. Here the rock types are both older and more variable in type. Several major faults cross this area. Mineralized belts of copper, lead and zinc are presently being mined here.

The margin between these two physiographic regions, the New Brunswick Lowlands in the east and the Nepisiguit highland area of the Miramichi Highlands in the west, has a number of pliestocene druminoid glacial deposits which have a marked expression on LANDSAT images of the area. These deposits divert the rivers which drain the highland areas into the Nepisiguit Bay and the Miramichi Bay.

There are two active hydrometric stations on Forty Mile Brook, the first at Caribou Depot and the second on the west branch Forty Mile Brook at Caribou Depot. These stations have been in regulated flow from a drainage area of 14.2 km^2, the second is on a natural regime watershed with a drainage area of 13.0 km^2.

The groundwater potential is limited mainly to bedrock supplies in most of the Nepisiguit Drainage Basin. Yields from bedrock (i.e., mainly metasediments and granite) are expected to be seldom greater than one litre per second. Except where mining has occurred, the water quality is expected to be good. Where mining has occurred the Nepisiguit River shows signs of water quality problems due to excessive copper, zinc and hydrogen ion concentrations which are probably related to the mining activity in this basin.

There is insufficient water quality information available to make a statement on the water quality of most watercourses in the basin. Except where mining has occurred the water quality is expected to be good. However, water quality monitoring is recommended on any watercourse which may be used for an industrial development. Water quality has been measured on Pabineau Lake, a tributary to Rocky Brook. Iron, lead, zinc, total hardness, chloride, calcium, magnesium, and sulphate were found not to be excessive, but pH is very low - the water is acidic. This is expected to be due to mining activities. The number of samples and duration of sampling was insufficient for any detailed conclusions to be drawn. Information has been obtained for Knight Brook, Forty Mile Brook, Austin Brook, and Portage Brook. The first three have a variety of water problems (see Tables 2.4-2.6) but based on a limited number of observations, Portage Brook appears to contain water of acceptable quality.

2.2.2 Water Use-Upper Nepisiguit Area

There are no municipalities or other settlements in this area. The Upper Nepisiguit River Basin is forested wilderness and the only activity in this area besides lumber is mineral exploration.

The only water quality related concerns in this area are associated with mineral explorations. The Anaconda mining operation discharges mining effluents into Forty Mile Brook. Until 1968 when the Wedge Mine ceased operations, Forty Mile Brook was also receiving discharges from this mine site. The mine shafts have since been sealed in order to prevent leakage and landscaping has stopped mine tailings from leaching into the brook. A portion of the Forty Mile Brook remains contaminated however.

There is no commercial navigation on the Nepisiguit River. Log driving on the river was discontinued in 1965, although the river was used in 1966 and 1967 for the storage of pulp. It is unlikely that log driving will even resume.

The recreational use of the Nepisiguit River seems to be restricted to some canoeing and angling. This was discussed in the Maritime Provinces Water Resources Study of 1969.

The major lake resources of the Nepisiguit Basin are concentrated close to the western margin of the watershed adjacent to Mount Carleton. This area, together with Big and Little Nictau Lakes in the Upper Tobique watershed are now under serious consideration for development as a major provincial park , with year-round operation.

It is interesting to note that the lakes in the upper portion of the Nepisiguit River Basin are as readily accessible to the residents of the upper reaches of the Saint John Valley as they are to those in the lower sections in Gloucester County. Indeed, until a road was recently constructed, linking Bathurst with the lakes, they were readily available only to the residents of Madawaska and Victoria counties.

Agricultural water use is expected to be no greater than 400 m3/day of which 70 percent is for irrigation.

Wildlife and fisheries are two major factors to be considered in planning any development (such as a power plant, or mining centre) along the Nepisiguit River Basin. Water quality suitable for wildlife and fish should be preserved. This river is slated for an enhancement and restoration program by Fisheries & Oceans Canada.

2.3 The Northwest Miramichi Area

2.3.1 General Discussion-Northwest Miramichi Area

The Northwest Miramichi Area is located in the north-central portion of the Newcastle-Chatham Planning Region. The major portion of this area is located in Northesk Parish in Northumberland County and the remainder of the area is located in the Southesk and Newcastle Parishes in Northumberland County and Allardville Parish in Gloucester County. There are no incorporated municipalities located within the Northwest Miramichi Area. Settlement is mainly along the highway which follows the northwest Miramichi River on its southerly course to the main river.

The Northwest Miramichi Area is defined as the Drainage Index Subdivision 1BO and includes all of the drainage basin of the Northwest Miramichi River System. The Northwest Miramichi Area is presented in Figure (2.4).

The northern boundary of the Northwest Miramichi Area extends to the drainage divide of the Nepisiquit River Basin; the southern boundary to the drainage area of the Little Southwest Miramichi River; the eastern boundary follows the divide between the Northwest Miramichi drainage in Northesk Parish and the Northwest Millstream drainage; the western limits extend to the South Branch Nepisiquit River and the Guagus Stream.

The Northwest Miramichi Area is mainly forest wilderness. The single major user of the water resources is Heath Steele Mines Ltd., located on the Little River, 51 km northwest of Newcastle and 64 km southwest of Bathurst. This operation is exploring sulphate deposits. At the present rate of production mine personnel suggest there is a reported 25 year known reserve. However, low metal prices and rising costs to the mining industry threaten this mine's continued operation.

The major rivers which are tributaries to the Northwest Miramichi River flow easterly following a zig-zagging course roughly parallel to the main river. They join the Northwest Miramichi River where it changes to a southerly course. The major rivers in this area include the Tomogonops River; the Little River; the Little Sevogle River; the Big Sevogle River. The Big and Little Sevogle Rivers are among the swiftest rivers in the province, and have practically continuous rapids and small falls along their courses.

The three largest lakes in the Northwest Miramichi Area are: Little River Lake, South River Lake and Mullin Stream Lake.

ENVIRONMENT N.B.
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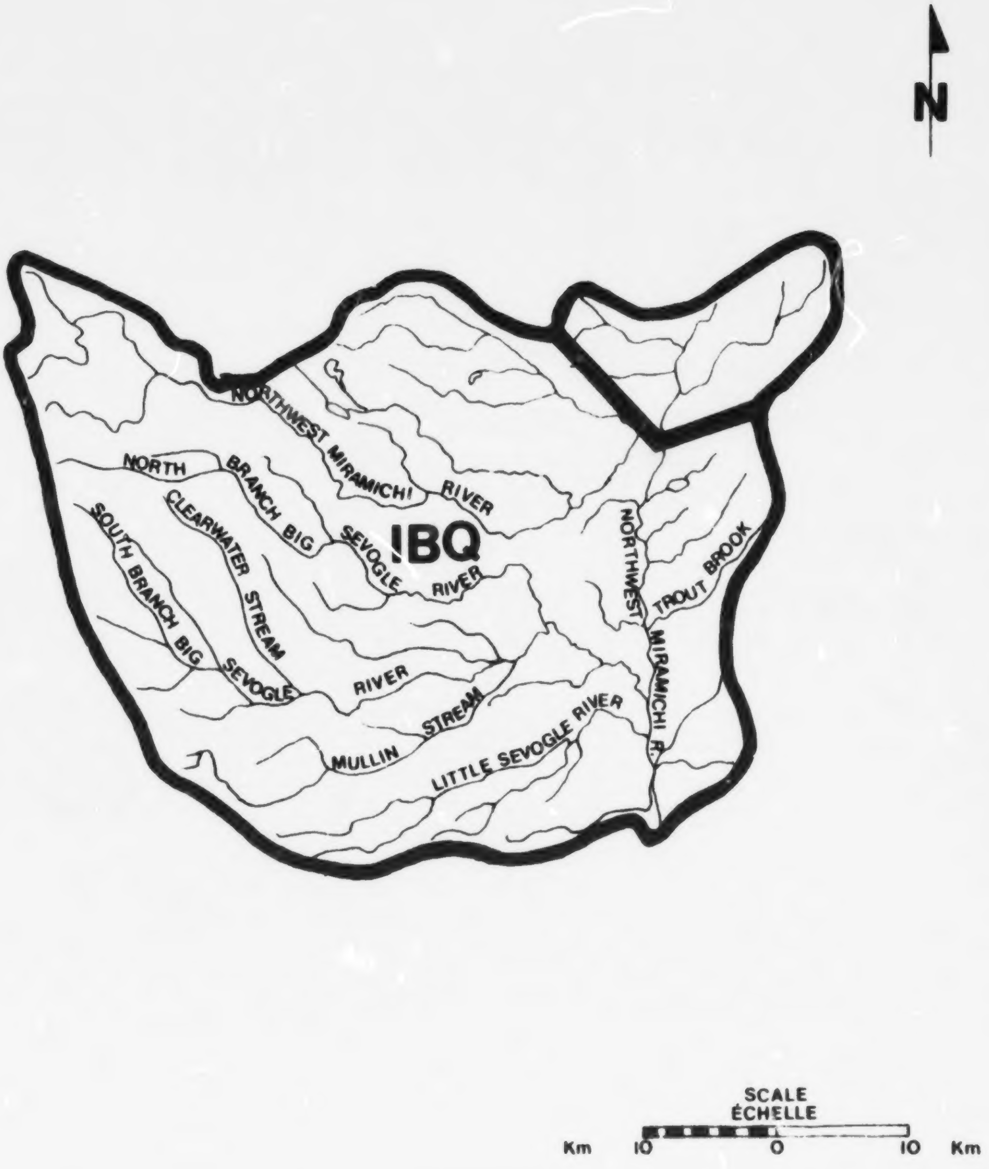
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NORTHWEST MIRAMICHI RIVER
NORTH BRANCH BIG SEVOGLE RIVER
CLEARWATER STREAM
SOUTH BRANCH BIG SEVOGLE RIVER
IBQ
NORTHWEST MIRAMICHI R.
TROUT BROOK
MULLIN STREAM
LITTLE SEVOGLE RIVER
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WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

LEGEND
LÉGENDE

▬ REGION BOUNDARY
LIMITES DE LA REGION
▬ HYDROMETRIC BOUNDARY
LIMITES HYDROMETRIQUES

NORTHWEST MIRAMICHI RIVER
IBQ
SECTEUR NORD-EST MIRAMICHI

FIG. 2.4

There are two active and 6 inactive hydrometric stations in the Northwest Miramichi Area. The active stations measure the natural flows of the Northwest Miramichi River at Trout Brook and the regulated flows of the Little South Grand Tomogonops River. The length of record at these active stations is 8 and 19 years. The drainage area of the Northwest Miramichi River at Trout Brook is 948 km2. The drainage area at the second location is not available. Flow duration curves for the hydrometric stations in the area are presented in Appendix E. Low flow frequency analysis of these stations are presented in Appendix F.

The locations of the hydrometric stations in the area are shown on the surface water map, Map 2. The hydrometric network is further discussed in Section 4.6.2.

The Northwest Miramichi River flows through two physiographic regions. The river which originates in the Central Highland Region of New Brunswick, follows an easterly course until it is joined by the Tomogonops River, At this point it turns southeast and begins its southerly course, flowing through Ordovician, Mississipian and/or Pennsylvanian formations and finally through the Pennsylvanian or younger formations found in New Brunswick Lowlands. At Sunny Corner it is joined by the Little Southwest Miramichi River and once again changes to an easterly course to outlet in the Miramichi River.

The highland plateaus in Northesk Parish range from 305 m to 610 m in height. The plateau is deeply dissected by the river valleys which form a well established drainage pattern. The area, with a large number of interfluvial ridges, is well drained as shown by the scarcity of lakes and swamps. The highest peak, 660 metres (- Mount Kagoot - Big Bald Mountain)is one of a series of high summits that form the divide between Big Sevogle and Nepisiguit Rivers.

The highland region of the Miramichi Basin is underlain by the Ordovician, Silurian and Devonian age rocks. The higher parts of the highlands are generally underlain by granite, quartz monzonite, granodiorite and related rocks of the Devonian or younger age. The New Brunswick Lowland areas of the Miramichi Basin are underlain by sandstones, conglomerates and siltstones of the Pennsylvanian or younger age.

The area appears to have been glaciated except for the top of Mount Kagoot and neighboring summits, but in the main, the river courses have not been greatly altered by glaciation other than a few local diversions. The lower course of the Big Sevogle River runs through the low lying plain underlain by a yellowish green, landed clay, covered in most places by a mantle of coarse gravel and soil. The till is generally then on the north of the Big Sevogle River.

An 8 metre section of the clay is exposed for about 2.4 km above the mouth. Recent aluvial material occupies the lower parts of the valley of the N.W. Miramichi River.

The rocks of the highlands will generally produce very small yields, a median of less than 1 litre per second from existing wells and variable quality water. The Devonian Age or younger rocks found at higher elevations will yield similar quantities of water of good quality.

Mining activities in the northern portion of the area have contributed to the deterioration of water quality in the Tomogonops River. Aluminium concentrations at Exmoor on the Northwest Miramichi River sometimes exceed recommended limits. Domestic waste is also contributing to the pollution of the Northwest Miramichi River.

2.3.2 Water Use-Northwest Miramichi Area

There are no municipalities located in the Northwest Miramichi Area. This area is almost entirely forested land. Settlement occurs mainly along the Northwest Miramichi River where it follows a southerly course to the area's boundary.

The portions of the area located outside the Northesk Parish boundaries are mainly unpopulated and represent wilderness areas. Therefore, the census figures for the Parish of Northesk may be assumed to be roughly representative of the Northwest Miramichi Area's population. The 1981 census reports a total population of 2910 for the Parish of Northesk. There are 835 occupied dwellings in the area.

Residents along the Northwest Miramichi River rely on private ground water supplies. Waste disposal is by way of private septic fields or cesspools. Results of recent testing on the Northwest Miramichi River at Exmoor indicate coliform counts in the section of the river exceeding the recommended limits. This suggests that improperly treated or untreated domestic waste is being allowed to flow directly into the river.

The one major industrial water user in the area is Heath Steel Mines Ltd., located on the Little River. The water used by this operation is secured from the Little River Lake and the Little South Tomogonops River. Mine officials give a consumption figure of 164 million litres per day. Potable water is from a ground supply with a well depth less than 30m. Pumping is about 0.3 litres per second.

Aluminum is present in the effluent of the Heath Steel mining operation and a water quality survey conducted in August 1981 detected elevated concentration levels of this metal at Exmoor on the Northwest Miramichi River. On an average day of operation, approximately 160 l/s of mine effluent is discharged into a holding pond. This effluent includes both underground mine water and contaminated surface runoff. The outflow of the holding pond discharges into the Tomogonops River. The production rate of Heath Steel Mills is 4250 tons/day and mine officials suggests there are 25 years of known reserves.

The recreational use of the Northwest Miramichi is limited to some canoeing and angling. Wildlife and Fisheries are two major factors to be considered in planning any development (such as a power plant or mining centre) within the Northwest Miramichi Basin. Water quality suitable for wildlife and fish habitat should be preserved.

2.4 The Little Southwest Miramichi Area

2.4.1 General Discussion-Little S.W. Miramichi Area

The Little Southwest Miramichi Area is located in the west central section of the Newcastle-Chatham Planning Region. The area is situated almost entirely within the boundaries of Southesk Parish in Northumberland County. Since the drainage of the Tuadook River in the far west corner of the area crosses the central west Northumberland County line, a small portion of both Victoria and York Counties are included in this basin area as well.

There are no incorporated municipalities within this area.

The boundaries of the Little Southwest Miramichi Area include the entire drainage system of the Little Southwest Miramichi River. A map of the Little Southwest Miramichi Area is presented in Figure (2.5).

Most of the largest lakes in Northumberland County are located in this drainage index subdivision. The most prominent lakes include Tuadook Lake, Jacks Lake, Holmes Lake, Mitchell Lake, Logan Lake, Guaqus Lake and Mains Lake.

The only hydrometric station within the Little Southwest Miramichi Area commenced operation in 1951. This station, located at Lyttleton, is monitoring discharge for a drainage area of 1340 km^2. The recording gauge has been in continual operation since 1966, a period of 18 years. The extreme maximum and minimum daily flows at this station are presented in Appendix D.

Many small tributary streams rise out of the Highland Lake region. The major rivers draining into the Little Southwest Miramichi River include: Tuadook River, W. Br. Little Southwest Miramichi River, North Pole Stream, Lower North Brook, Little S.W. Miramichi River, Gauqus Stream, Devils Brook, Catamaran Brook and Parks Brook.

The greater part of the Little Southwest Miramichi Area may be described as a fairly level plateau averaging about 305 m in elevation. The plateau slopes gently to the east away from the elevated and rugged grantic area of the central part of the province. The plateau is deeply and rather sharply dissected by the river valleys, which form a well established drainage pattern. The area, with a large number of interfluvial ridges, is well drained, as is shown by the relative scarcity of lakes. The boundary

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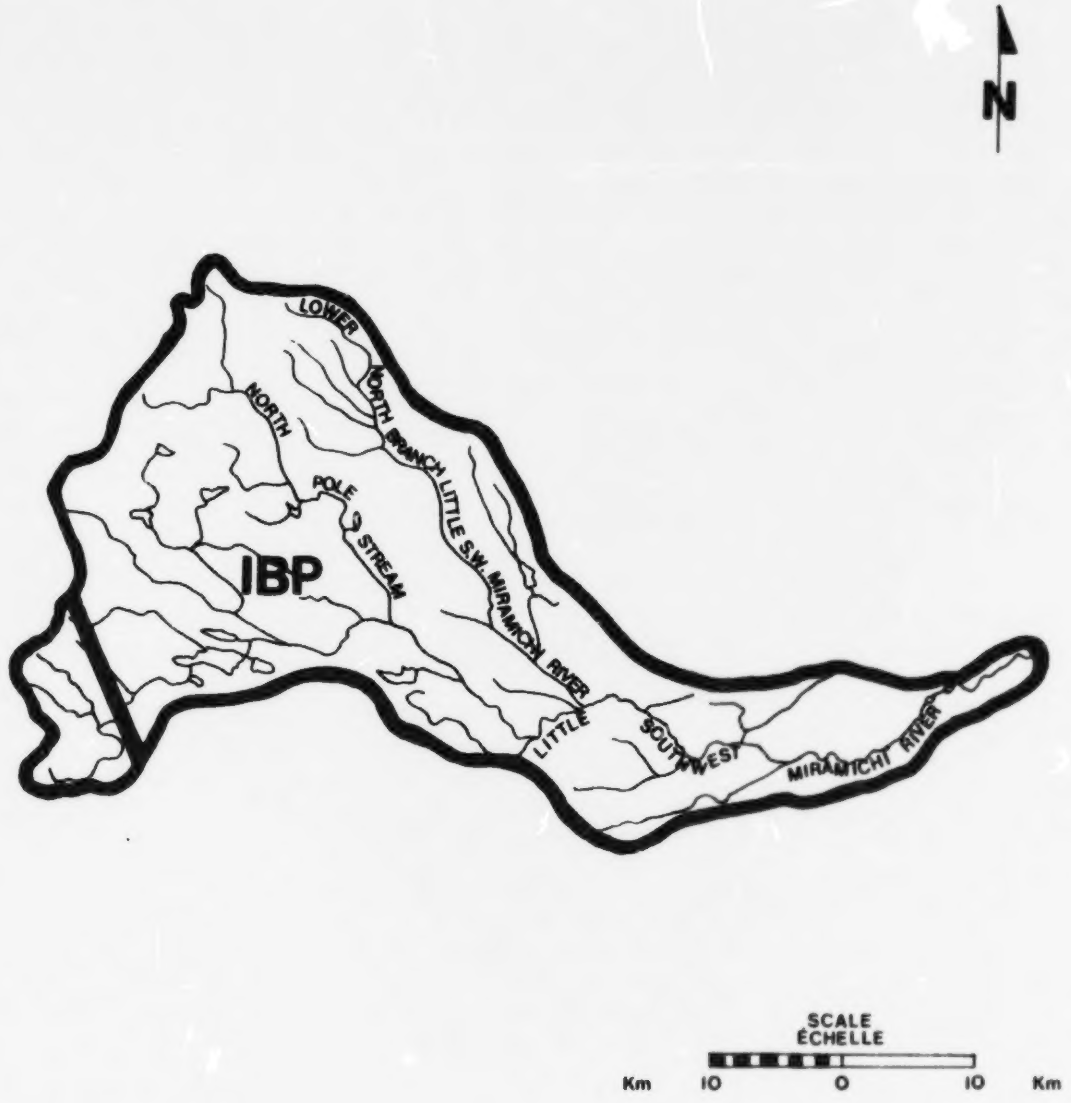
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REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

LITTLE SOUTHWEST MIRAMICHI AREA
IBP
SECTEUR PETIT MIRAMICHI SUD OUEST

FIG. 2.5

line between the Carboniferous and older rocks is more or less coincident on either side of Little Southwest Miramichi River with a relatively abrupt rise to the west, a topographic feature that is referred to locally as Catamaran ridge on the south side of the river, and Tomahawk ridge on the north side. The river valleys in this area are deepest about midway between source and mouth. The maximum depth of the valley of the Little Southwest Miramichi River is in the vicinity of Devils Brook and is about 122 m. The rivers generally follow a zig-zag course, alternating between the directions parallel to and normal to the strike of the rocks.

The Little Southwest Miramichi Area is located within the physiographic boundary of the New Brunswick Highlands.! This region of the Miramichi Basin is underlain by Ordovician, Silurian and Devonian Age rocks. The higher parts of the highlands are generally underlain by granite, quartz monzonite, grandodiorite and related rocks of the Devonian or younger age.

The rocks of the highlands generally produce very small yields, a median of less than 1 l/s from the existing wells and variable quality water. The Devonian Age or younger rocks found at higher elevations will yield similar quantities of water and of good quality.

2.4.2 Water Use-Little Southwest Miramichi Area

There are no incorporated communities within the Little Southwest Miramichi Area. The area represents the least populated area within the Newcastle-Chatham Planning Region. Settlement is sparse and is located in the far eastern portion of the area along the banks of the Little Southwest Miramichi River. There is minimal use of the water resource in this area for domestic purposes and no water is needed by industry. Although forest operations in this mainly forested wilderness of the Miramichi does not require water, the adequate control of these forest land operations now and in the future should be provided in order to insure the continued quality of water and preserve the fish and wildlife habitat.

The Little Southwest Miramichi River is very well known for its sport fishing. Numerous lakes in the highland region and the unpolluted isolated wilderness streams provide the area with great recreation and tourism potential.

2.5 The Estuarine Tributary Area

2.5.1 General Discussion-The Estuarine Tributary Area

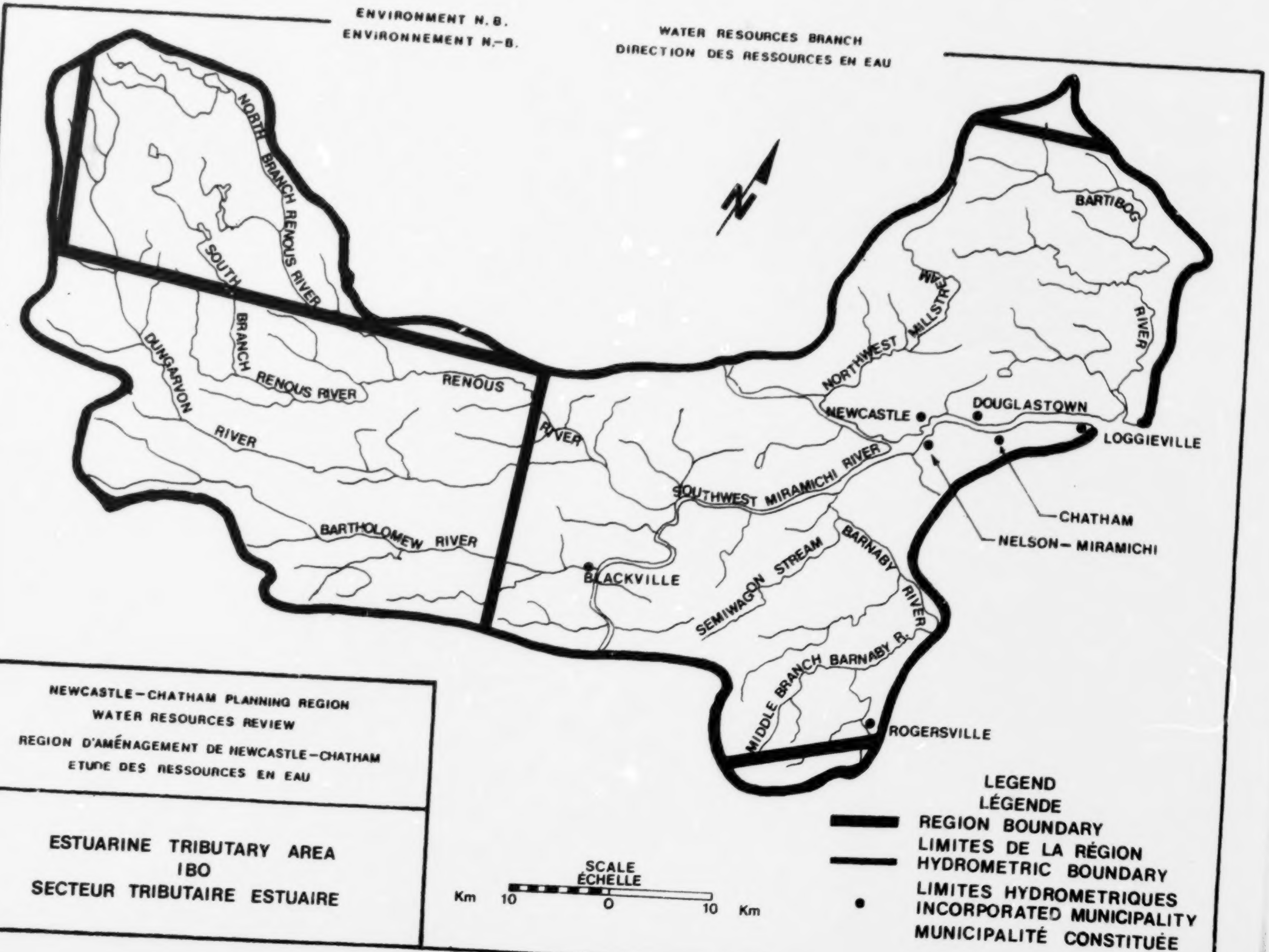
The Estuarine Tributary area encompasses the southern portion of the Newcastle-Chatham Planning Region. This drainage index subdivision comprises parts of all but one of Northumberland's 10 parishes. These Parishes are Southesk, Ludlow, Blissfield, Blackville, Nelson, Newcastle Chatham, Rogersville, Glenela and Alnwick. The Parish of Northesk is the only parish which is almost totally excluded from this drainage index subdivision. There are portions of the area which lie outside the County of Northumberland but these represent small and generally inconsequential water resources for the Newcastle-Chatham Planning Region. The western half of the Estuarine Tributary Area encompasses the Renous Game Reserve and the unsettled southwest corner of Southesk Parish. The Estuarine Tributary Area is shown on Figure (2.6).

All of the region's incorporated municipalities with the exception of the Village of Nequac are located within the Estuarine Tributary Area. These municipalities include the towns of Newcastle and Chatham and the villages of Blackville, Douglastown, Nelson-Miramichi and Loggieville all of which are situated along the Southwest Miramichi River on Route 8 and the estuarine Miramichi River. The Village of Rogersville is the only incorporated municipality which is not located on the main Miramichi watercourse. It is situated near the Barnaby River in Rogersville Parish.

The Estuarine Tributary Area is the centre of population concentration for the Newcastle-Chatham Planning Region. The twin ports of Chatham-Newcastle are the regional service centres and the villages dotting the shore line of the Miramichi River are 'company towns' and serve as small service centres, mainly for the forestry sector.

The Estuarine Tributary Area is identified as Drainage Index Subdivision 1B0. The boundary defining the western half of this area extends to include the drainage areas of the Renous, Dungarvon and Bartholomew Rivers. These rivers and their tributaries cut through the Parishes of Southesk, Ludlow, Blissfield and Blackville in a series of small valleys which join the larger valley of the Southwest Miramichi Rivers in the central portion of the area (Parish of Blackville).

The eastern half of the area located north of the estuarine river includes almost all of the Parish of Newcastle-those portions which include the drainage basins of the Bartibog River and the Northwest Millstream. The boundary line extends from the Gloucester-Northumberland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SOUTH BRANCH RENOUS RIVER
RENOUS RIVER
DUNGARVON RIVER
BARTHOLOMEW RIVER
BLACKVILLE
SOUTHWEST MIRAMICHI RIVER
SEMIWAGON STREAM
BARNABY RIVER
MIDDLE BRANCH BARNABY R.
ROGERSVILLE
NORTHWEST MILLSTREAM
NEWCASTLE
DOUGLASTOWN
LOGGIEVILLE
CHATHAM
NELSON- MIRAMICHI
BARTIBOG RIVER
SCALE
ÉCHELLE
Km 10 0 10 Km
LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA RÉGION
HYDROMETRIC BOUNDARY
LIMITES HYDROMETRIQUES
INCORPORATED MUNICIPALITY
MUNICIPALITÉ CONSTITUÉE

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WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE–CHATHAM
ETUDE DES RESSOURCES EN EAU

ESTUARINE TRIBUTARY AREA
IBO
SECTEUR TRIBUTAIRE ESTUAIRE

FIG. 2.6

2.5 The Estuarine Tributary Area

2.5.1 General Discussion-The Estuarine Tributary Area

The Estuarine Tributary area encompasses the southern portion of the Newcastle-Chatham Planning Region. This drainage index subdivision comprises parts of all but one of Northumberland's 10 parishes. These Parishes are Southesk, Ludlow, Blissfield, Blackville, Nelson, Newcastle Chatham, Rogersville, Glenelg and Alnwick. The Parish of Northesk is the only parish which is almost totally excluded from this drainage index subdivision. There are portions of the area which lie outside the County of Northumberland but these represent small and generally inconsequential water resources for the Newcastle-Chatham Planning Region. The western half of the Estuarine Tributary Area encompasses the Renous Game Reserve and the unsettled southwest corner of Southesk Parish. The Estuarine Tributary Area is shown on Figure (2.6).

All of the region's incorporated municipalities with the exception of the Village of Nequac are located within the Estuarine Tributary Area. These municipalities include the towns of Newcastle and Chatham and the villages of Blackville, Douglastown, Nelson-Miramichi and Loggieville all of which are situated along the Southwest Miramichi River on Route 8 and the estuarine Miramichi River. The Village of Rogersville is the only incorporated municipality which is not located on the main Miramichi watercourse. It is situated near the Barnaby River in Rogersville Parish.

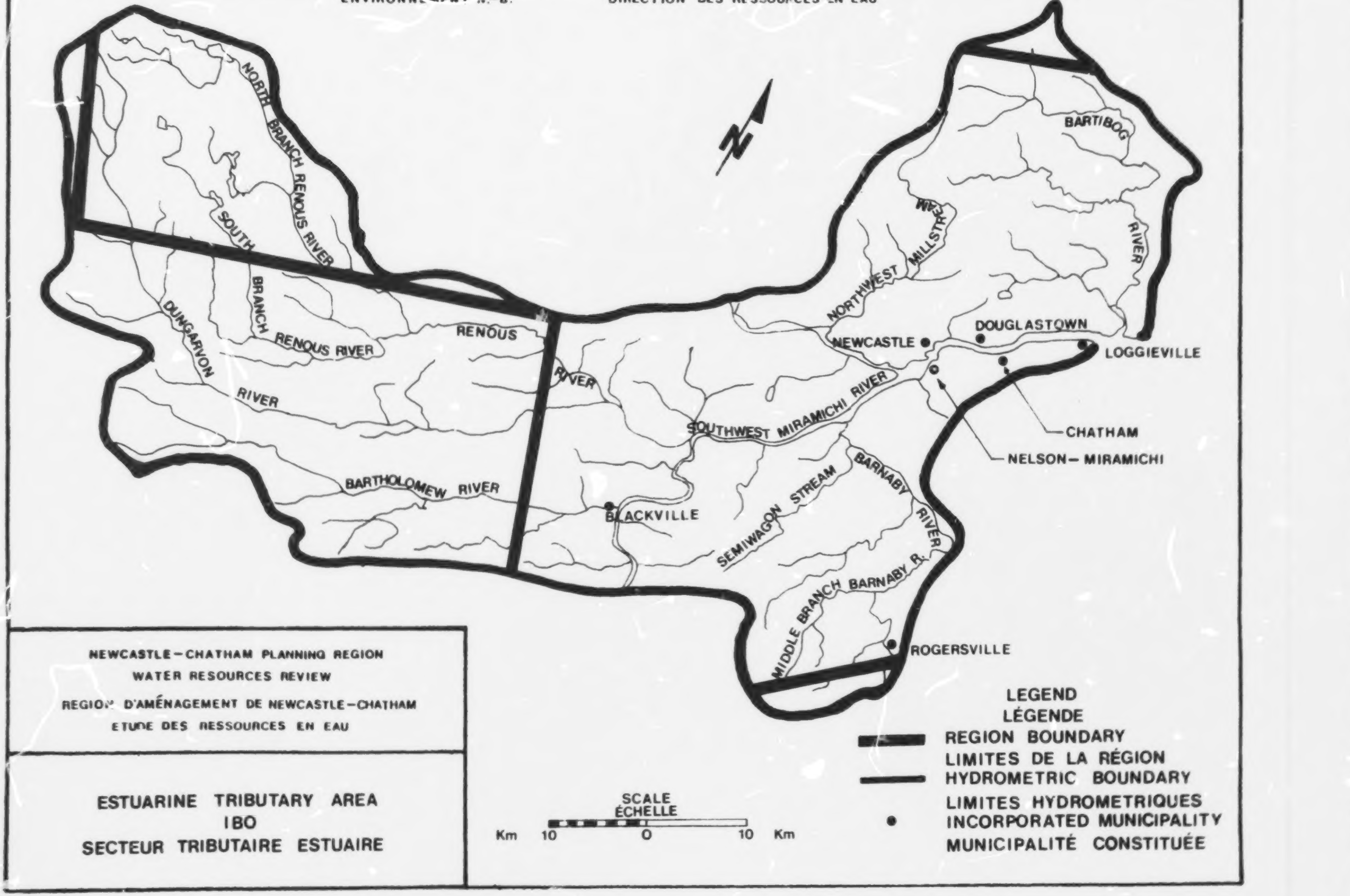
The Estuarine Tributary Area is the centre of population concentration for the Newcastle-Chatham Planning Region. The twin ports of Chatham-Newcastle are the regional service centres and the villages dotting the shore line of the Miramichi River are 'company towns' and serve as small service centres, mainly for the forestry sector.

The Estuarine Tributary Area is identified as Drainage Index Subdivision 1B0. The boundary defining the western half of this area extends to include the drainage areas of the Renous, Dungarvon and Bartholomew Rivers. These rivers and their tributaries cut through the Parishes of Southesk, Ludlow, Blissfield and Blackville in a series of small valleys which join the larger valley of the Southwest Miramichi Rivers in the central portion of the area (Parish of Blackville).

The eastern half of the area located north of the estuarine river includes almost all of the Parish of Newcastle-those portions which include the drainage basins of the Bartibog River and the Northwest Millstream. The boundary line extends from the Gloucester-Northumberland

ENVIRONMENT N.B. — ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH — DIRECTION DES RESSOURCES EN EAU


NORTH BRANCH RENOUS RIVER
SOUTH BRANCH RENOUS RIVER
DUNGARVON RIVER
RENOUS RIVER
BARTHOLOMEW RIVER
BLACKVILLE
SOUTHWEST MIRAMICHI RIVER
SEMIWAGON STREAM
BARNABY RIVER
MIDDLE BRANCH BARNABY R.
ROGERSVILLE
NORTHWEST MILLSTREAM
NEWCASTLE
DOUGLASTOWN
LOGGIEVILLE
CHATHAM
NELSON – MIRAMICHI
BARTIBOG RIVER
N
SCALE
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LEGEND
LÉGENDE
REGION BOUNDARY
LIMITES DE LA RÉGION
HYDROMETRIC BOUNDARY
LIMITES HYDROMETRIQUES
INCORPORATED MUNICIPALITY
MUNICIPALITÉ CONSTITUÉE

NEWCASTLE–CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE–CHATHAM
ETUDE DES RESSOURCES EN EAU

ESTUARINE TRIBUTARY AREA
IBO
SECTEUR TRIBUTAIRE ESTUAIRE

FIG.2.6

County line and follows the course of the Bartibog River in the east to the mouth of the estuary and the Northwest Millstream in the west to the junction of the Little Southwest and the Northwest Miramichi Rivers. The Northumberland-Kent County line defines the boundary to the south.

The major rivers in this area include the Renous River, Dungarvon River, Bartholomew River, Barnaby River, Northwest Millstream and Bartibog River. There are few lakes in this area. The largest lakes in the area are North Renous Lake, Louis Lake, Kennedy Lake and McKendrick Lake. These lakes are located in the Highland Region of Southesk Parish.

There are three active hydrometric stations in the Estuarine Tributary Area. These measure the natural flows of the Southwest Miramichi at Blackville, Renous River at McGraw Brook and Barnaby River below Semiwagon River. The length of record at these stations is 16, 16 and 8 years respectively and the drainage areas are 5050 km^2, 611 km^2 and 484 km^2 respectively. Flow duration curves for the hydrometric stations in the area are presented in Appendix E. Low flow frequency analysis of these stations are presented in Appendix F.

The topography of the northwest portion area is dominated by the New Brunswick Highlands while the southeastern half of the area lies within the New Brunswick Lowlands. The middle section of this drainage contains some carboniferous sandstone, while the western third of the area (Southesk. Ludlow, Blissfield parishes) contains more igneous rock. The main classes of rock in the area are Pennsylvanian, Triassic, Silurian and Devonian. The eastern half of the Miramichi River Basin, the Estuarine River area, is generally of low relief and lies in the Gulf of St. Lawrence Plain. The northwestern section is part of the New Brunswick Highlands.

Generally, the plateau of the highlands slopes to the east away from the elevated and rugged granite area of the central part of the province toward the low-lying Carboniferous plain bordering the Atlantic Ocean. A considerable width of glacial outwash and outwash-delta deposits are found in those portions of the area north and south of the Estuarine Miramichi River. Along the estuary, from Derby Head to Chatham, these deposits extend over an average width of 13 km excluding the estuary. A thin strip of Mississippian and/or Pennsylvanian conglomerates and siltstones found along the watercourses of the Miramichi River system are potential high capacity aquifers. Dependable yield of aquifers can be expected to be less in the upper reaches of the river basin. Available data on existing wells indicate that the Pennsylvanian or younger age groups of rocks in New Brunswick have yielded a median of 16 litres per second. The rocks of the highlands will generally produce very small yields.

Generally, the surface water of the Estuarine Tributary Area is of excellent chemical quality. The quality of groundwater found in this drainage index subdivision is somewhat variable. Saltwater intrusion has contaminated groundwater in a zone approximately 305 metres wide along the south bank of the Miramichi estuary (Environment New Brunswick, 1976). High manganese concentrations, water hardness and the isolated occurrence of iron in some municipal supplies cause minor problems. Water quality, overpumping and diminishing well yields are persistent problems for the municipality of Chatham.

Variations appear in well yield since aquifer boundaries are sometimes controlled by nearby impervious barriers and by surface recharge.

2.5.2 Water Use-The Estuarine Tributary Area

The Estuarine Tributary Area is the largest area within the Newcastle-Chatham Planning Region. Seven of the region's eight incorporated municipalities are located within this region; the towns of Newcastle and Chatham and the villages of Blackville, Nelson-Miramichi, Douglastown, Loggieville and Rogersville. The towns of of Chatham and Newcastle and the Village of Douglastown obtain their municipal water supply from groundwater sources. The villages of Blackville, Loggieville, Nelson-Miramichi and Rogersville have groundwater supplies secured from privately owned wells. Some 60 dwellings in Blackville use two spring-fed surface water reservoirs as their source of water supply. The remainder of the village uses private groundwater wells. A detailed discussion of each municipality's water supply is presented in Chapter 3 of this report.

Among the major industrial water users in this area, are Boise-Cascade Canada Ltd. and Domtar Chemicals Ltd. Boise-Cascade draws water from the Miramichi River for use in the pulp mill processing and draws an additional 0.15 million litres per day from Newcastle's public water supply. The total amount of water used by this industry is approximately 75 to 85 million litres per day.

Domtar Chemicals Ltd. is also connected to the town of Newcastle's municipal water supply. The amount of water needed by this industry for domestic and fire protection purposes was not metered until the summer of 1982. At that time, indications were that Domtar used 0.55 million litres per day of water from this public source to supplement its private groundwater supply. No figures are available to indicate the company's total water consumption from both sources. The concern of officials in Newcastle's water works department is the possibility of contamination of the municipal water supply because of the absence of a check valve on the Domtar supply line.

Other commercial and industrial enterprises which draw their water from Newcastle's municipal water supply used approximately 0.38 million litres per day for the twelve month period, July 1981 to June 1982 inclusive. A detailed discussion of Newcastle's municipal water supply is presented in Section (3.8).

The water supply of the municipality of Chatham also serves the adjacent Canadian Forces Base in Chatham, the town's biggest water consumer. The base draws 1.1 million litres per day from the town's water supply. A private ground source no longer supplies supplements to the base's water supply. A detailed discussion of Chatham's municipal water supply is presented in Section (3.3).

The New Brunswick Electric Power Commission operates a 35 megawatt thermal generating plant at Chatham. During the years 1981 and 1982 the plant was in operation only 11 days. The average daily water consumption is now 0.02 million litres per day. This is secured from Chatham's municipal water supply. The present rate of consumption does not compare with 0.09 million litres per 8 hour shift needed for cooling purposes when the plant is in full operation. The Chatham thermal plant has been the site of a federally funded project involving alternate fuel research. Until such time, probably in the year 1983, as this research project ("carbogel" testing) resumes, water consumption at the plant will remain minimal.

All of the municipalities in the Estuarine Tributary Area, with the exception of Loggieville, are serviced by wastewater treatment systems. The Village of Blackville and the adjoining Local Service District of Chatham Head installed sewage collection and treatment facilities in 1982. In the same year, the Village Council of Loggieville, presumably following the suggestion of a public opinion poll, rejected installing a similar system in their community.

Although its economic importance is not comparable to that of the forest based industry, the commercial fishery based in the Miramichi area constitutes a significant resource. The salmon is the mainstay of the fisheries in the Miramichi River and its many tributary branches. Cottage development, licensing, servicing, supplying together with the annual sale of leased waters and riparian rights have given the recreational fisheries a significant value in the Miramichi Area.

However, pollution of the estuary and the estuarine Miramichi River and overfishing have resulted in a declining salmon population. Stringent conservation measures have been in effect over the past decade. The Miramichi fisheries resource is critically related to the maintenance of the water quality. The value of the fisheries to the Estuarine River Basin areas (in common with other Miramichi areas) extends beyond economics into the realm of aesthetics and the social well-being of the local inhabitants.

2.6 The Central Southwest Miramichi Area

2.6.1 General Discussion-Central Southwest Miramichi Area

In order that the Newcastle-Chatham Planning Region include all drainage basins of the Miramichi River system and for the purpose of maintaining consistency in regional report formats, this portion of the Southwest Miramichi drainage (1BN) will be included in its entirety in the Newcastle-Chatham Planning Region.

The drainage index subdivision 1BN lies mainly within the Fredericton Planning Region and has been discussed under the area designation of the Miramichi Headwaters (1BN and 1BM). This report intends to discuss only area 1BN, the Central Southwest Miramichi, which includes all of the drainage basin of the Cains River, a major tributary to the Miramichi River. Except where specific reference is made to the Central Southwest Miramichi River, the following is extracted from the Fredericton Planning Region Water Resources Review, (New Brunswick Department of the Environment, 1980).

The central Southwest Miramichi Area forms the lower western portions of the Newcastle-Chatham Planning Region. The area lies within the lower half of the Parishes of Blackville, Blissville, Ludlow in Northumberland County and within the northwest portions of Maugerville Parish, in Sunbury County, St. Mary's and Stanely Parishes in York County.

The area (1BN) includes the drainage of that section of the Southwest Miramichi River at the western Northumberland County boundary to just below its confluence the Cains River. The boundaries of the Central Southwest Miramichi Area extend west, south and east to include the drainage basin area of the Southwest Miramichi's main tributaries between the county boundary in the west and downstream of the Cains River confluence. The physical descriptions of these rivers and other selected watercourses in the area are presented in Appendix G.

The Southwest Miramichi River is the major river in the area. The Cains River is the area's only major tributary.

Two small lakes are located in the Ludlow Parish area. Salmon Brook Lake has a surface area of 0.3 km^2 and Muzroll Lake has a surface area of 0.5 km^2. The surface areas of these lakes are presented in Table 2.2. The Central Southwest Miramichi area is shown in Figure (2.7).

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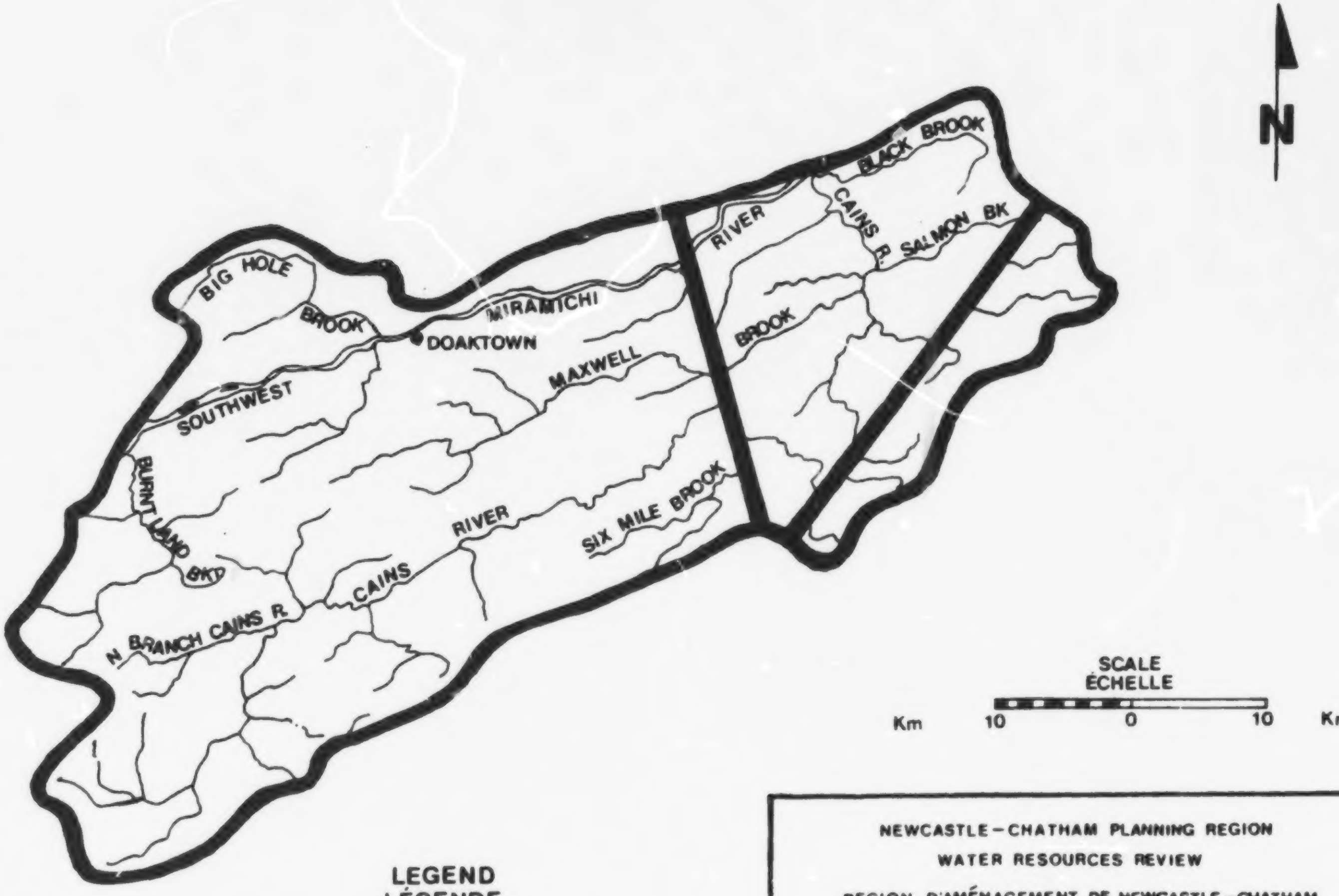
N
BIG HOLE BROOK
SOUTHWEST
MIRAMICHI
DOAKTOWN
RIVER
BURNT LAND BKD
N BRANCH CAINS R.
CAINS
RIVER
MAXWELL
BROOK
SIX MILE BROOK
CAINS R.
BLACK BROOK
SALMON BK
SCALE
ÉCHELLE
Km 10 0 10 Km

LEGEND
LÉGENDE

- ▬ REGION BOUNDARY
  LIMITES DE LA RÉGION
- ▬ HYDROMETRIC BOUNDARY
  LIMITES HYDROMETRIQUES
- ● INCORPORATED MUNICIPALITY
  MUNICIPALITÉ CONSTITUÉE

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

CENTRAL SOUTHWEST MIRAMICHI AREA
IBN
SECTEUR SUD-OUEST MIRAMICHI CENTRAL

FIG. 2.7

There are no hydrometric stations in this area (1BN). The central portion of the Province of New Brunswick lacks hydrometric representation. Further installment of hydrometric stations in this area should be considered (Environment Canada and New Brunswick Department of New Brunswick).

The eastern half of this area is underlain by flat lying Pennsylvanian sandstones and shales and the western half by highly folded sedimentary rocks and intrusive igneous rocks of the Ordovician, Silurian and Devonian period. The unconsolidated material covering the bedrock is for the most part glacial till generally less than 1m in thickness. Glacial outwash deposits are found along the main Miramichi River and major tributaries.

The groundwater potential for the area is considered to be best in these areas of fractured Pennsylvanian sedimentary rocks. Wells constructed in these areas may yield up to 7.6 l/s. Wells constructed in the folded sedimentary sequences or the intrusive granites will probably yield sufficient water for domestic use but not enough to support a municipal or industrial well. Water supplies developed in the unconsolidated deposits are vulnerable to contamination from any material left on the land surface. In addition to being vulnerable, they may produce insufficient water to satisfy the needs of a modern household.

Groundwater quality could be considered as very good throughout the basin. However, water quality in the area underlain by Pennsylvanian sediments is expected to be inferior to that of the western basin due to excessive iron and manganese concentrations.

2.6.2 Water Use-Central Southwest Miramichi Area

The population in the Central Southwest Miramichi Area is concentrated along a strip of the Southwest Miramichi River and Highway 8. The remainder of the area is almost devoid of population. There are no incorporated communities within this area. Settlements rely on either drilled wells or private springs for their water supply. Homes are serviced by septic tanks and/or cesspool installations.

Recreation and tourism in the area are mainly based on Atlantic Salmon fishing. The fisheries resources of the Miramichi River are important not only to the economy of the area but also to the province. The water demands of the fisheries resource are more critically related to quality than to quantity and the maintenance of suitable water qualities is a major concern in the Miramichi area.

Recreational boating is exercised on a number of small lakes in the headwaters and canoeing activities principally take place in the salmon waters.

Agricultural activity today is confined to a strip along the Southwest Miramichi River. The main crops are livestock related such as hay, although there are small areas for vegetables and strawberries. In general, the water demands for agriculture are very small.

There is no major mining activity within the area although several companies are presently exploring to the west of Doaktown-Boiestown. Future mining activity could have an impact on the water quality in the area.

In general, domestic, commercial and industrial water demands in the Central Southwest Miramichi Area are extremely small in relation to the available resources in the area.

2.7 The Miramichi Bay Area

2.7.1 General Discussion-Miramichi Bay Area

The Miramichi Bay Area is located in those portions of Northumberland County which border on the outer embayment (Miramichi Inner Bay). The outer embayment, for the purposes of this report, includes the portions of the Bay east of Sheldrake Island.

The parishes of Alnwick, Glenelg and Hardwicke and portions of Rogersville and Chatham Parishes are included on the Miramichi Bay Area. There is only one incorporated municipality in this area. The Village of Neguac is located on the shore of Neguac Bay in Alnwick Parish. The Miramichi Bay Area is shown on Figure (2.8).

The Miramichi Bay Area is defined as that portion of the Drainage Index Subdivision 1BL which is located north of the outer estuarine Miramichi River in Alnwick Parish and that portion of the Drainage Index Subdivision, 1BR which lies south of the Miramichi Bay in Glenelg Parish. The northern and southern boundaries of the area are defined by the Northumberland County Line. The western divide in Alnwick Parish follows the course of the Bartibog River. In Glenelg Parish the western boundary extends in a north-south direction to include the Napan River and Bay du Vin River drainage.

On the north shore area in Alnwick Parish, the Tabusintac River Basin is the largest River in the Drainage Index Subdivision 1BL. Slightly more than half of the river basin (52 per cent) lies inside the Bathurst Planning Region but the river empties into the Tabusintac Lagoon near Wishart Point, in the Newcastle-Chatham Planning Region. As most of the basin's communities lies near the mouth of this river, it is probably of more importance to the residents of the Newcastle-Chatham Planning Region.

In the Maritime Provinces Water Resources Study (Montreal Engineering Co. Ltd. 1969) the following information was presented for the Tabusintac River Basin upstream of Gaythorne.

Basin Area	653 km^2
Estimated mean annual precipitation	940 mm
Precipitation less runoff	390 mm
Average elevation	100 mm
Area of lakes	0 km^2
Area of swamps	9.0 km^2

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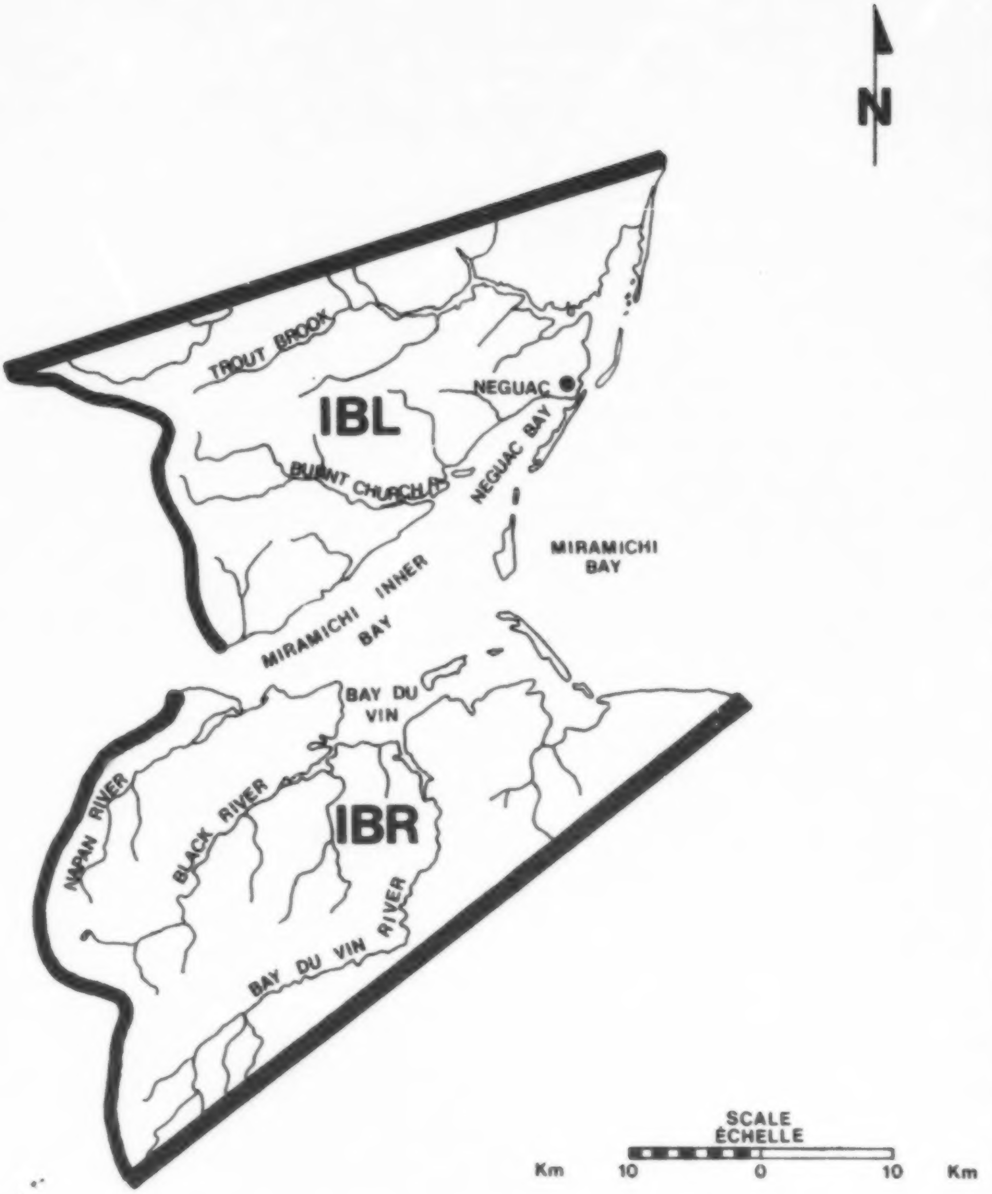
N
TROUT BROOK
IBL
NEGUAC
NEGUAC BAY
BURNT CHURCH R.
MIRAMICHI BAY
MIRAMICHI INNER BAY
BAY DU VIN
IBR
NAPAN RIVER
BLACK RIVER
BAY DU VIN RIVER
SCALE
ÉCHELLE
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LEGEND
LÉGENDE

━ REGION BOUNDARY
LIMITES DE LA RÉGION
— HYDROMETRIC BOUNDARY
LIMITES HYDROMETRIQUES
● INCORPORATED MUNICIPALITY
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NEWCASTLE - CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE - CHATHAM
ETUDE DES RESSOURCES EN EAU

MIRAMICHI BAY AREA
IBR, IBL
SECTEUR BAY DU MIRAMICHI

FIG. 2.8

Other major rivers in this area include the Bartiboq River and Burnt Church River, both with outlets to the Miramichi River Bay. The combined drainage area of these two rivers is 256.5 km^2. The south shore area has 5 major river basins. These are Nappan River, Black River, Bay du Vin River, Eel River and Portage River. Their combined drainage area is 285.9 km^2. There are no lakes in the Miramichi Bay Area.

The portions of the Drainage Index Subdivisions, 1BL and 1BR, which are located within the Miramichi Bay Area lie within the Gulf of St. Lawrence Plain region of the New Brunswick Lowlands. This is an area of low relief (90-150 m) of flat or gently dipping Upper Palaeozoic sedimentary rocks formed from continential or brackish water sediments and are chiefly sandstone, shales and conglomerates. They are less compact than the Lower Palaeozoic Age which underly the Highland region and are more easily eroded.

The following information relating the probable aquifer locations and well yields located in overburden deposits is taken from the Maritime Province Water Resources Study (Montreal Engineering Company Ltd., 1969):

> The Carboniferous rocks which underlie the New Brunswick Lowlands are supposedly the Province's best aquifers. Wells located in these rocks are capable of yielding 1.5 to 38 litres per second each. A survey of a number of existing wells, reported a median yield of 17 litres per second of good quality water. Variations from the probability rates are to be expected because of local differences in rock permeability and fracture and fault occurrences.
>
> The natural recharge from nearby surface water systems make the low areas the best possible locations for high capacity overburden aquifers. Large groundwater yields are expected from areas of glacial outwash and outwash-delta deposits such as are found along the lower Miramichi.
>
> The groundwater quality from overburden aquifers will closely reflect the quality of water recharging these aquifers. Poor quality is expected from shore deposits because of the possibility of salt water intrusion; from organic deposits, both because of small quantities and poor quality; and from glacial till because of the relative impermeableness of these deposits. High manganese content is often associated with organic deposits.

2.7.2 Water Use - Miramichi Bay Area

The domestic water requirements of residents of the Miramichi Bay Area are supplied by private wells. The water supply in the Village of Neguac is obtained from private wells varying in depth from 4 metres to 90 metres.

The smaller streams flowing into Miramichi Inner Bay have limited value as angling streams. Those streams flowing into the Bay du Vin have insufficient nutrients and spawning areas for the production of sport fish. This is also true of the Burnt Church River. Other small tributaries of Miramichi Inner Bay are poor producers of sport fish due primarily to the natural variations of water level and discharge.

The Tabunistac River flows into Tabunistac Bay, an inlet of the Gulf of St. Lawrence, near the northeastern corner of the Miramichi Bay Area. Its value as a fisheries stream is somewhat better than other coastal watercourses in the Miramichi Bay Area, but the Tabunistac River does not have the proper amount of nutrients in its water for it to be classified as having a high capability for the production of sports fish.

CHAPTER THREE

THE COMMUNITY WATER SUPPLIES

3.1 Introduction

There are eight incorporated municipalities within the Newcastle-Chatham Planning Region. All but two of these are located along the Southwest Miramichi River usually referred to as the Main River) and the Estuarine Miramichi River. These communities had their origins in the lumber industry and shipbuilding industry. Today these same communities still service local forestry based industry and their port facilities continue to export the Miramichi's natural resources from forests, mines and fisheries. One other community is located on the north shore of Miramichi Inner Bay and another is situated near the Northumberland-Kent County Line on the Barnaby River.

Three of the eight incorporated communities have municipal water supply systems, as shown on Table (3.1). All eight of the incorporated communities have adequate water supply for the purpose of fire fighting. Ground water, whether private or public, is the source of water supply for all communities. The Village of Blackville has a number of dwellings serviced by a surface supply as well. Water for fire fighting is often supplemented with surface supply.

Only two of the incorporated communities remain without sewage treatment facilities. The villages of Neguac and Loggieville, both of which are currently experiencing problems of inadequate or improperly draining septic fields, are without public sewage collection and sewage treatment facilities.

There are many advantages for having public water supply and disposal systems in an urban community. The major advantage is that the water supply is drawn from a single source which can be under continuous control with regard to the quantity and quality of water. Such control may include: source protection, ownership, monitoring of quality and consumption, evaluation of source capacity, and "real" management. A public disposal system also eliminates private well contamination, a problem that is always associated with sewage handling (mostly septic tanks). Proper fire protection can be provided under a water supply system. This in turn can reduce fire insurance premiums and encourages business and industrial development which enhance the economy of the community.

The following sections outline the present and projected features of the various incorporated communities in the Newcastle-Chatham Planning Region and the associated water supply considerations.

TABLE (3.1) GENERAL INFORMATION ON WATER SUPPLIES AND WASTE TREATMENT SYSTEMS

Municipality (1981 census population)	Status	Water Supply				Wastewater Treatment Systems		
		System	Source	Ave.flow Million Lit/day	Treatment Plants	Availa-bility	Ave.flow Million Lit/day	Treat-ment Plants
Blackville (892)	Village	No	Ground/ Surface	—	—	Yes	Under Construction	
Chatham (6,779)	Town	Yes	Ground	5.68	No	Yes	3.41	1
Douglastown (1,091)	Village	Yes	Ground	0.29	No	Yes	0.58	1
Loggieville (781)	Village	No	Ground	—	—	—	—	—
Neguac (1,755)	Village	No	Ground	—	—	—	—	—
Nelson-Miramichi (1,452)	Village	No	Ground	—	—	Yes	Under Construction	
Newcastle (6,284)	Town	Yes	Ground	4.82	No	Yes	7.27	
Rogersville (1,237)	Village	No	Ground	—	—	Yes	0.09	2

Source: Water Resources Branch, New Brunswick Department of the Environment

3.2 The Village of Blackville

The Village of Blackville, incorporated on November, 1966, is located in the Parish of Blackville in Northumberland County. The village is situated on both sides of the Southwest Miramichi River with the centre of the village located at the confluence of the Bartholomew River with the main Southwest Miramichi River. The access highway to the village is Highway 8 connecting to Fredericton in the Southwest and to Newcastle-Chatham in the Northeast.

Servicing the local forest industry is the main economic activity in Blackville. The village's main employer, a sawmill, has ceased operations. Rayonier Wood Products Ltd., manufacturers of chip board, remain the only major industry in Blackville. Prospects for future economic growth of the Village are not positive. Village officials do not anticipate any appreciable future residential development.

Population: Census information for the Village indicate a decreasing population trend. In 1981 there were 892 individuals in 281 occupied dwellings.

YEAR	POPULATION
1971	-
1976	924
1981	892

Water Supply: The Village of Blackville is not serviced by a public water supply. A concrete dam at the outflow of a spring (located approximately 450 metres from Mrs. Percy Beckwith's property, on Hillcrest), See Figure (3.1), services 58 dwellings. A gravity feed and private lines distribute water from this spring reservoir (41,000 - 45,000 litre capacity) to dwellings located below (north of) Bartholomew River Bridge. An additional six homes in the village receive their supply from another private spring fed reservoir. Private wells with average depths between 24 - 29 metres provide upper (south) Blackville with water. See Figure (3.1) for a plan of the municipality.

Water Quality: The water quality from private supplies is now described by village officials as "good" but water quality surveys done by the New Brunswick Department of the Environment show that water from private wells have high contents of iron and manganese. For example, the school is presently using water where the iron content is 0.04 mg/l and the manganese, 0.6 mg/l. Manganese exceeds the maximum acceptable limit of 0.05 mg/l set by the Canadian Drinking Water Quality (1978).

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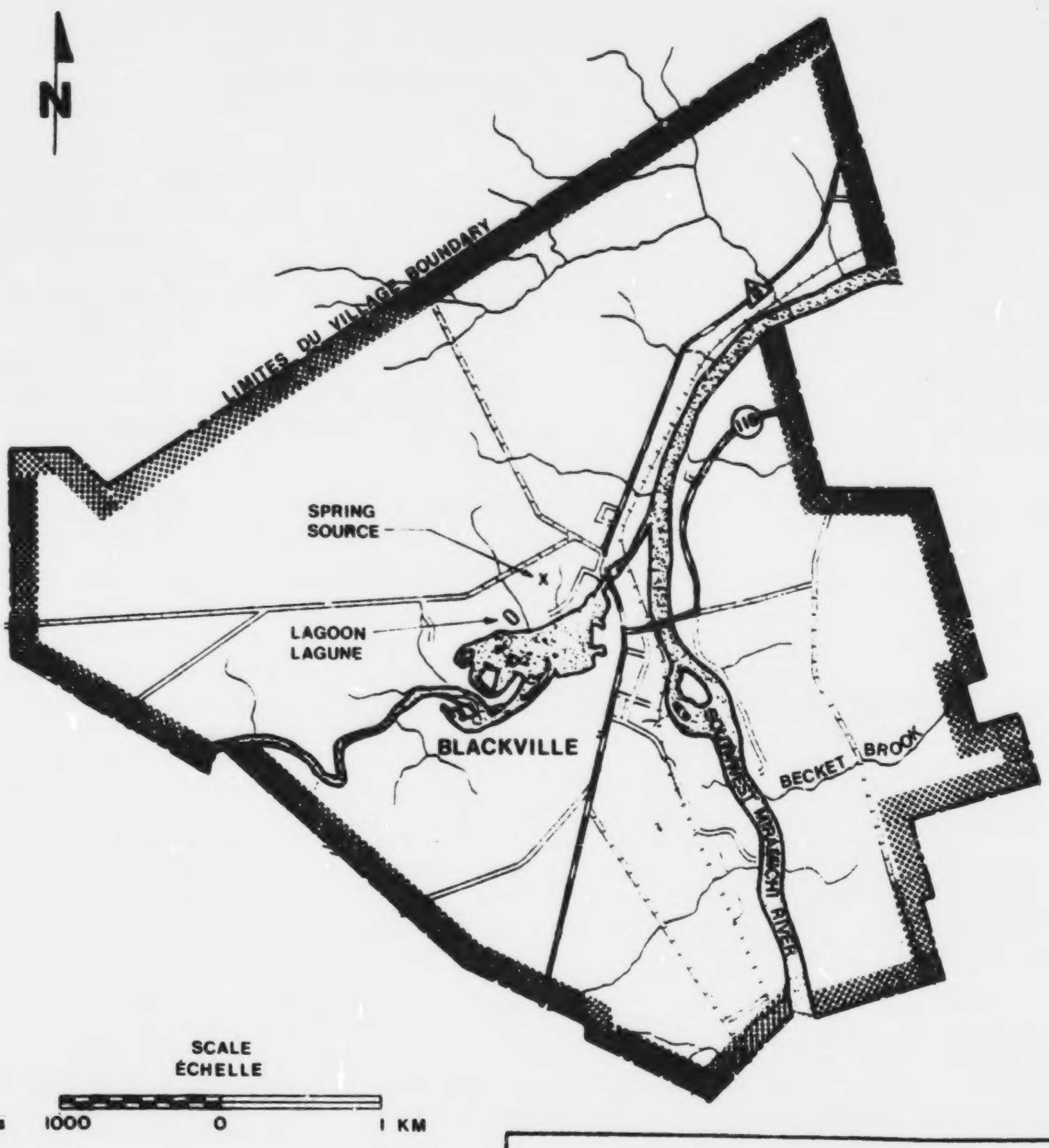
N
LIMITES DU VILLAGE BOUNDARY
8
118
SPRING SOURCE
X
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BLACKVILLE
SOUTHWEST MIRAMICHI RIVER
BECKET BROOK
SCALE
ÉCHELLE
Metres 1000
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NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

WATER SOURCES
BLACKVILLE
SOURCES D'EAU

FIG. 3.1

Hydrogeological Study: The results of a hydrogeological study (Crandall, 1980) done in 1979-1980 suggest that there is little to choose between potential areas located within the municipality. That is, there should be no significant difference in either quality or quantity of water from any wells located within the village boundaries.

The consultants recommended that a municipal groundwater supply be secured from wells located about 760 metres from the intersection of Lochstead Road and McLaggan Road. A storage tank at this location would provide the street pressure required during periods of peak demand. The yield of a production well at this location is expected to be within 7.6 - 11 litres per second. The water quality of test holes were marginal since manganese exceeded the acceptable standard set by the Canadian Drinking Water Quality, 1978 but it was suggested that the levels are comparable or better than the levels in many of the present house wells in Blackville. Manganese appears to be present throughout most of the area. Development of induced precipitation of the manganese may be possible through design considerations on the standpipe and associated facilities (Crandall, 1980).

Waste Water Treatment: A wastewater system was installed in the Village of Blackville during the summer of 1982. Waste water treatment consists of a 2.9 hectare lagoon located west of Highway 8 and south of the Bartholomew River. This is combined with five dry wells located over a 0.8 hectare area. Overflow from the lagoon, possibly during spring freshet, would be received by the Bartholomew River. Fifty of sixty dwellings within the municipality are not connected to the public system. See Figure (3.1) for location.

Fire Protection: The Village has two tankers and the Fire Department now gets their water from the private spring fed reservoir in the village and has access to the hydrant on the closed mill site. A 28 metre well serves the fire station building. The town council would eventually like to see three wells with submersible pumps constructed to secure the community's fire protection needs.

3.3 The Town of Chatham

Location: The Town of Chatham, located in Chatham Parish in the County of Northumberland, is situated on the South side of the Miramichi River. Chatham is 8 km below the Town of Newcastle, located on the opposite side of the river. The Miramichi Centennial Bridge (Highway 8) in Chatham and the Morrissey Bridge (Highway 118) in Newcastle provide these communities with access across the Miramichi River. The Town of Chatham is connected to Bathurst in the north and Fredericton in the southwest by Highway 8 and to Moncton in the south by both Highway 126 and 11.

The elevation of land within the municipality of Chatham varies from one metre above sea level along the east waterfront to 57 metres at the corner of Victoria Avenue and Henderson Street. Physiography of the area is dominated by the Miramichi River flowing in a northeasterly direction. Both banks of the river slope gently and slopes of 1 in 30 (0.035) are typical. A plain at an elevation of approximately 30 metres above mean sea level adjoins the slope on the southern (right) bank of the river. This plain is drained mainly by two small intermittent streams; one flowing southwesterly (to the Chatham reservoir), the second northeasterly (Black Brook). The area as a whole is well drained except around Chatham Lake and the upper Black Brook drainage basin where more swampy terrain occurs reflecting layers of silt, peat and muck with low permeability.

The water depth in the Miramichi River within the town limits of Chatham is known to reach at least 15 metres. Ships having a draft of 6.4 metres can be taken in or out at both Chatham and Newcastle. The Miramichi River is tidal for 24 km above Newcastle.

Historical Background: Chatham was incorporated as a Town in June 1896. It was founded because of its strategic sheltered location on the Miramichi River, which is only 8 km inland from the open Miramichi Bay. It flourished as a main shipbuilding yard in the 19th century. In the early 20th century, Chatham was caught in the decline of the wooden shipbuilding and sawmill industries. By the mid-20's industry had been replaced by manufacturing and service industries. The town now also serves as an auxiliary dormitory and service function to the Canadian Forces Base. The settlement pattern of Chatham is a tight cluster around the commercial core and docks with residential sprawl along the radial roads. The location of the Air Force Base has resulted in another cluster of residential and commercial buildings on the southern limit of town.

Population: The census population of the Town of Chatham increased at a large rate between 1941 and 1961 as shown in the following table. The establishing of CFB Chatham in 1940 and the subsequent influx of personnel and their families account for this population increase as Chatham was established as a local service community. A slow decrease of population is observed beginning in the late 60's. This decline was due to the trend of urban migration at that time. The general state of the depressed economy in the Miramichi Region and the uncertain future of the Air Base may have long term effects for the Chatham area. Town officials do not anticipate population growth for their community. There are a total of 2010 occupied dwellings within the municipality (1981 Census).

YEAR	POPULATION
1941	2,082
1951	5,323
1961	7,109
1966	8,136
1971	7,833
1976	7,601
1981	6,779

History of Supply: The Town of Chatham's original (1901) water system was composed of three wells and a surface water supply from a dam on Morrison Brook. These were abandoned a few years later for a surface supply from two storage dams on Morrison Brook.

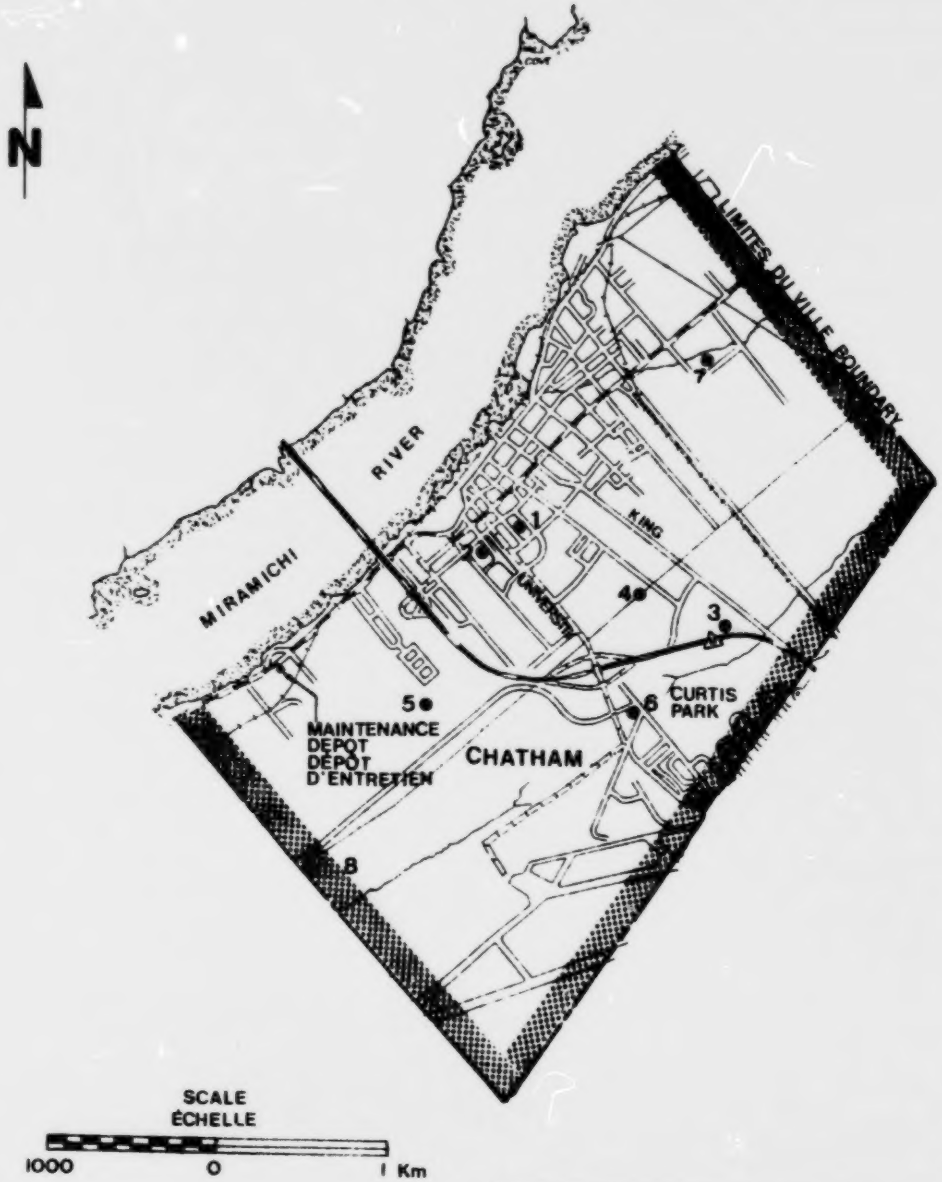
During the early 40's, the Town began chlorinating its supply and three new wells were drilled, Town Park, Cassidy and Ellis Wells. (See Table 3.2 for details of well construction).

During the early 50's, the surface supply was abandoned in favour of a ground water supply. This was probably for economic reasons as consumption was increased during this period of time due to building of CFB Chatham and NBEPC generating station.

By the 1960's, the contamination and diminished yield of the Ellis Well necessitated the addition of three more wells to the system in the downtown area at Richard, Howard and Duke Streets. By 1968, the Ellis Street well was producing chlorides in excess of 300 ppm, the recently completed Duke Street Well yield had been reduced because of chloride contamination and the Town Park Well had been abandoned because of diminished yield. In 1975 the Ellis Street Well was abandoned because of excessively high chloride concentration. When originally tested after a 60 hour time period in 1954, the Ellis Street was producing water with a chloride concentration of 11ppm.When abandoned the chloride concentration was as high as 850 ppm. See Figure (3.2) for well locations. See Table (3.2) for details of production wells.

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
LIMITES DU VILLE BOUNDARY
RIVER
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KING
1
4
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CURTIS PARK
MAINTENANCE DEPOT
DEPOT D'ENTRETIEN
CHATHAM
SCALE
ÉCHELLE
Metres
1000
0
1 Km

LEGEND
LÉGENDE

● **WELLS**
PUITS

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

WATER SOURCES
CHATHAM
SOURCES D'EAU

FIG. 3.2

Table (3.2) DETAILS OF PRODUCTION WELLS IN CHATHAM*

WELL NAME	WELL NO. ON FIGURE 3.2	YEAR DRILLED OR IN PRODUCTION	DEPTH m	DIAMETER cm	PUMPING RATE 1/s	AVERAGE YIELD MILLION LITRES PER DAY 1/day	COMMENTS
WELLS IN PRODUCTION							
Cassidy Well #1	1	1951	76	20	10	1.0	
Richard Well	2	1960	137	30	4 - 5	0.49	
Henderson St. Ext. Well #4	3	1975	61	25	7	0.68	
Henderson St. (Body Shop Well)	4	1976	91	25	11	1.18	
Nichol St. Well	5	1976	107	25	8	0.82	
Martin St. Well	6	1977	91	25	13	1.34	
Industrial Park (Walsh Ave)	7	1981	91	20	13	1.31	
Gordon(Kelly)	[illegible]	1980	95	25	15	1.30	
WELLS OUT OF PRODUCTION							
Town Park Well		1942	110	25	20		
Ellis		1945	137	25	33		
Duke		1960	122	25	14		
Howard		1967	91	20	15		

*All wells are bedrock. Pumping rates are not rated capacities. Units are converted to metric

NOTE: Information source for production wells is Town Superintendent.
Information source for out of production wells is Maritime Provinces Water Resources Study, Montreal Engineering Ltd. 1969

Present Supply: In the early 1970's additional exploration led to development of four wells positioned at greater distances from the estuary of the Miramichi. They are the Henderson St. (Eugene Hill Well), Henderson St. Extension, Nicol St. and Martin Street Wells.

The Town of Chatham now obtains its water supply from eight deep wells (average depth is 90 metres) with pumping (turbine pumps) capacities ranging from 11 to 17 litres per second. Information on well production is presented in Table (3.2). All wells pumping simultaneously at the reported rates represent a total potential pumpage of 75 litres per second. Total potential pumpage is about 12% higher than the present use of 66 litres per second.

During the past decade (1971-1981) the actual water demand on Chatham's municipal supply has remained almost unchanged at approximately 5.68 million litres per day. However, the number of residents served by the supply has decreased by 1,033 during this period of time. So, fewer people are using greater quantities of water at a time when industrial and institutional demand has not significantly increased.

Considering the 1981 census population of 6,779, and excluding the water demand of 0.72 million litres per day by CFB Chatham on the municipal supply, the per capita consumption of water by Chatham residents is in the vicinity of 730 litres/day. This is significantly higher than many other New Brunswick communities. Inadequate metering, distribution line leakage and excessive wastage are possible explanations for this difference. See Table (3.3), (3.4) and Figure (3.3) for information related to population count and water consumption.

Distribution System: The distribution system consists of 15-30 cm cast iron water mains. A storage tank, with 2.7 million litre capacity, gravity feeds water mains at approximately 2.5 kg/sq cm. inlet pressure. There have been no major changes in distribution setup in the last 25 years other than extensions to areas of new development (Gordon Road, Kelly Road, Industrial Park, etc.). Industrial consumption is not expected to increase in the foreseeable future.

Twenty water meters are in service for major users. CFB Chatham is the town's biggest consumer. N.B.E.P.C. is the Town's second major water user.

TABLE (3.3) WATER DEMAND-TOWN OF CHATHAM (1901-1981)

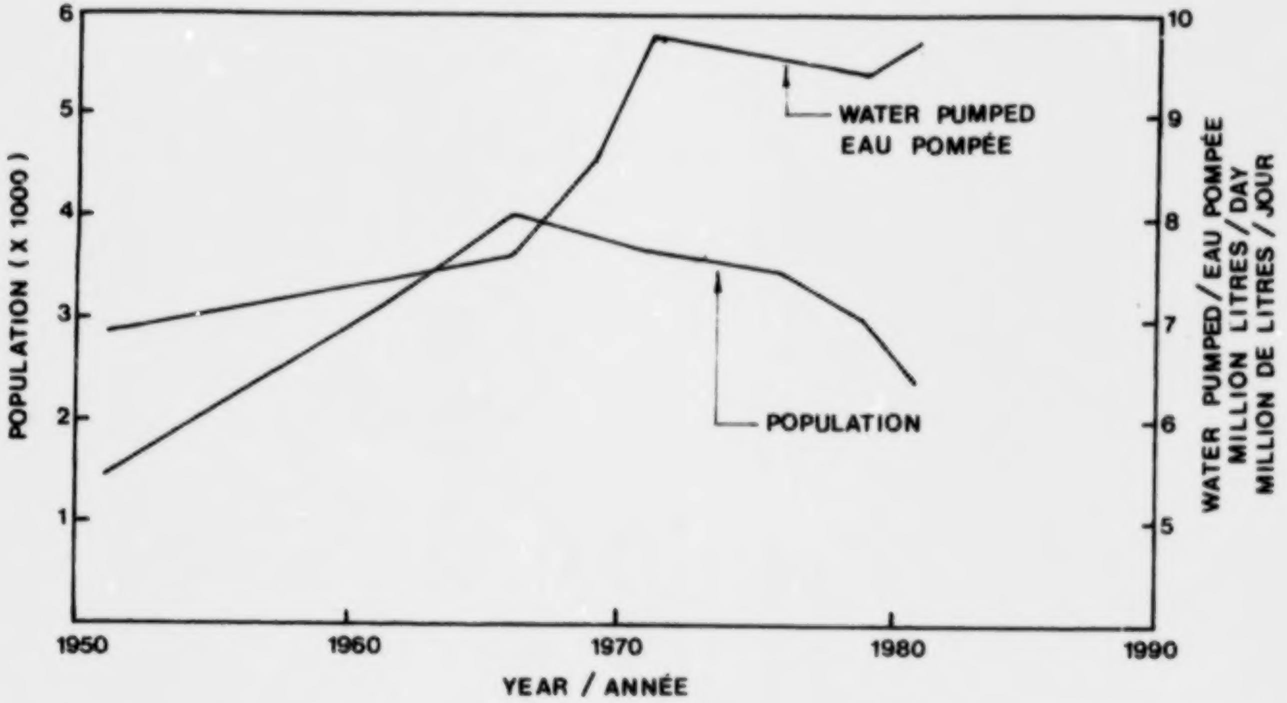
YEAR	POPULATION	AVERAGE TOTAL DEMAND (Million Litres Per Day)
1901	4808	2.55[1]
1951	5323[2]	----
1961	7109[2]	----
1966	8136[2]	3.73[3]
1969	7941[4]	4.55[5]
1971	7833[2]	5.68[6]
1976	7601[2]	----
1979	7108[4]	5.46[1]
1981	6779[2]	5.68[7]

1. Groundwater Resources, 1976
2. Census population figure
3. Brandon, 1967
4. Interpolation
5. Maritime Provinces Water Resources Study, 1969
6. Foundation of Canada Engineering Corporation Ltd., 1974
7. This Report

TABLE (3.4) PER CAPITA WATER CONSUMPTION-CHATHAM (1981-1982)

Total consumption	5.68 million	litres/day	
CFB Chatham	0.71 "	"	"
N.B.E.P.C.	0.02 "	"	"
Domestic Consumption (approx)	4.95 "	"	"
Population (1981 census)	6779		
Per capita demand (approx)	730 litres/day		

ENVIRONMENT N.B. WATER RESOURCES BRANCH
ENVIRONNEMENT N.-B. DIRECTION DES RESSOURCES EN EAU



NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

POPULATION AND WATER PUMPED
CHATHAM
POPULATION ET EAU POMPÉE

FIG.3.3

CFB Chatham: The Canadian Forces Base at Chatham obtains its water supply from the municipal water supply. In November 1984, 1.1 million litres per day was used by the base. A 60 metre deep well on the base was discontinued due to high manganese levels. This supply serves a resident population of 2580 people (416 private P.M.Q. dwellings). The per capita consumption is therefore approximately 465 litres per day.

The water is treated to remove iron and manganese. Both fluoride and chlorine are added to water consumed by the base's users. The quality of the water is described as hard, with high iron and manganese concentrations. For the past four years the "taste" of the water has been unpleasant. C.F.B. Chatham has attempted to secure a backup well but design problems with the well have been encountered and are not yet resolved. This well is not producing a useable water supply.

Two reservoirs with 1.8 million litres total capacity, pump water at 2.8 to 4.5 kg/sq. cm. pressure. Pipe losses once caused a 0.7 kg/sq. cm. pressure drop through the distribution system, but the problem has been corrected.

The C.F.B. Chatham has secondary sewage treatment with mechanical aeration to meet the needs of a community of 2580. Storm and sanitary sewers are separated. However, in the event of heavy rainfall or a sudden thaw, infiltration of surface runoff into the collection system makes it necessary to by-pass the plant and direct waste water into the Nepan River.

N.B.E.P.C. Chatham: The N.B.E.P.C. Chatham Thermal Generating Station, with two units operating, has an installed capacity of 35 megawatts. This plant has operated eleven days during the period 1981 to August 1982. During this time daily water needs have averaged 0.02 million litres per day. This does not compare with .09 million litres per shift when plant was in full production.

A backup supply of water is obtained from a 67 metre deep well located adjacent to old Commission House 820 metres from the plant. The Municipality of Chatham provides a supply of water.

An early (1967) well located adjacent to the Miramichi River was abandoned in 1971 when chloride levels rose from 79 ppm to 230 ppm over the three month period.

Chatham's municipal water supply could not be relied upon because of fluctuating chloride content and this supply was abandoned in 1972 in favor of the present "Commission House" well.

The N.B.E.P.C. Thermal Generating Station at Chatham has lately been the site of a federally funded project involving alternate fuel research. Until such time, probably in the year 1983, as the project ("carbogel" testing) resumes, water consumption at the plant will be minimal.

Water Quality: Water quality, overpumping and diminishing well yields continue to be problems for groundwater users in Chatham area. A groundwater resources study (Environment New Brunswick, 1976) in the Chatham Area shows that the intrusion of salt water has contaminated groundwater in a zone approximately 305 metres wide along the south bank of the Miramichi estuary. The source of the contamination appears to be a combination of salt water from the estuary and upconing of deep seated salt water induced by closely spaced, high capacity wells in the central area of Chatham. A trend of increasing contamination is indicated.

Recent analyses confirm the high manganese concentration in four of the town's wells - Cassidy, Richard, Henderson and Industrial Park wells, (See Table 3.5). Manganese exists in the soluable reduced form in oxygen-deficient waters. As the waters become oxygenated, manganese in finely disseminated form may be precipitated. Bacterial interaction with manganese may be prevented by chlorination or some other technique. Overpumping of wells may also aggravate this problem by increasing the amount of oxygen poor water entering the well. Cassidy and Richard wells produce exceptionally hard water also.

In 1972, a significant oil spill occurred 3 km south of the Town of Chatham at the Gulf oil bulk storage terminal. Approximately 1.05 million litres of diesel fuel spilled and was only partially recovered. There has been no evidence of fuel seepage along the natural groundwater discharge zone adjacent to the spill. It is assumed that the lost fuel is either trapped by local lithology or has migrated laterally to immobility, (Groundwater Resources Chatham, 1976). It is possible that a potential problem could develop if the existing hydraulic gradients in the area were to be reversed by overpumping.

Table (3.5) CHEMICAL ANALYSIS - TOWN OF CHATHAM (AUGUST 1982)

PARAMETER		Cassidy Well #1	Richard Well	Henderson Extension Well	Nicol Street Well	Henderson Street Well	Martin Street Well	Industrial Park Well	Town Hall Water	MAXIMUM ACCEPTABLE LIMITS (CDWQ, 1978)
Potassium	mg/1	3.2	2.1	2.3	1.1	1.4	1.1	2.1	2.7	
Calcium	mg/1	87.	60.	29.	15.	28.	15.	60.	76.	200.
Flouride	mg/1	L.1	L.1	L.1	.13	L.1	.12	L.1	L.1	1.5
Nitrate	mg/1	L.01	L.01	L.01	L.01	L.01	L.01	L.01	L.01	10.
Alkalinity	mg/1	110.	97.	89.	88.	82.	88.	100.	106.	30 to 500
Conductivity	us/cm	1100.	830.	310.	250.	270.	250.	800.	860.	
pH	NTU	7.6	7.7	8.1	8.3	7.9	8.3	7.7	7.6	6.5 to 8.5
Turbidity	mg/1	.18	.79	.21	.20	.18	.16	.24	.19	5.0
Nitrite	mg/1	L.01	L.01	L.01	L.01	L.01	L.01	L.01	L.01	1.0
Sodium	mg/1	63.	60.	15.	29.	8.9	28.	61.	58.	270.
Iron	mg/1	L.05	L.05	L.05	L.05	L.05	L.05	L.05	L.05	0.3
Manganese	mg/1	*.72	*.20	.04	.03	*.25	.03	*.23	*.55	0.05
Copper	mg/1	L.01	L.01	L.01	L.01	L.01	L.01	L.01	L.01	1.0
Lead	mg/1	L.05	L.05	L.05	L.05	L.05	L.05	L.05	L.05	0.05
Zinc	mg/1	L.01	L.01	L.01	L.01	L.01	L.01	L.01	L.01	5.0
Aluminum	mg/1	L.1	L.1	L.1	L.1	L.1	L.1	L.1	L.1	
Chloride	mg/1	230.	200.	13.	8.7	9.9	8.4	200.	*330.	250.
Silica	mg/1	19.	8.0	11.	12.	15.	11.	13.	15.	
Magnesium	mg/1	18.	11.	4.7	2.3	4.3	2.4	11.	15.	150.
Hardness	mg/1	*291.345	*195.107	91.763	46.924	87.619	47.336	195.107	*251.527	120.
Sulfate	mg/1	26.	28.	21.	13.	11.	16.	28.	24.	500.

*Concentration exceeds guidelines for Canadian Drinking Water Quality, 1978
Source: Water Resources Branch, Department of the Environment, New Brunswick

Aquifer properties in the Chatham area indicate that maximum well yields differ according to location. The rapid responses of test wells in the Chatham area and increases in chloride concentration during test pumping suggest fracture permeabilities must be significant (Environment New Brunswick, 1979). Pumping rates and pumping centres must be selected carefully to reduce the overpumping stresses of excessive drawdown and interference drawdown between wells.

Diminishing well yields is a problem noted in wells of all major groundwater users in the Chatham area. In many instances this may be a result of deterioration of unprotected borehole walls. Improved well construction methods,and improved management are indicated for future supply wells.

Town of Chatham officials are concerned about deteriorating water quality. The town is looking to a CFB Chatham groundwater source location or to the Morrison Cove area as two possible sources of future supply.

Waste Water Treatment: An oxidation ditch type sewage plant with activated sludge provides secondary waste water. treatment for the Town of Chatham. Located on Lower Water Street the system with a design capacity of 3.86 million litres per day has an average flow of 3.41 million litres per day. The plant was sized by Godfrey Associates Limited for a population of 8,000 and now serves a population of 6779 (1981 census).

The original outlets for overflow into the Miramichi River are now used only during times of extremely high flows or pump failure. Until such time that a new industry discharges a significant amount of wastes into the Chatham sewage system, the waste treatment facilities that now exist should adequately serve the needs of Chatham's declining population. See Table (3.6) for an analysis of the conditions of the treatment plant in Chatham. In the autumn of 1984, storm and sanitary sewers were installed along Warren, Green and Tait Streets.

Flooding: Flooding is not a serious threat to the Town of Chatham which is located sufficiently high above the Miramichi River. A storm surge accompanied by heavy precipitation occurred in 1974. Drainage problems caused basement flooding in buildings on McIntosh Street, Riverside Drive and Duke Streets. The 1940 flood resulted in only slight damage to the Chatham area.

ACTIVATED SLUDGE WASTEWATER FACILITY
USINES D'EPURATION A BOUE ACTIVEE

Municipality
Municipalité Chatham

Capacity
Capacité 0.83 M.I.G.D.

Type of process
Genre de procédé FOSSE D'OXIDATION OXIDATION DITCH

Design population
Population de desigh 8320

Operator
Opérateur CHARLES SPRAY

Major industries
Industries majeures

Average values obtained
Valeur moyenne obtenues

Year Année	BOD/DOB (mg/1)		SS/MS (mg/1)		TKN/ATK(mg/1)		TPO_4 (mg/1)		MLSS/ MSLM (mg/1)	MLVSS MVSLM (mg/1)
	in	out	in	out	in	out	in	out		
1980	79	10	91	10					2650	727
1982	141	48	99	243	17	17	12	11	2665	1839

Table 3.6 Analysis of Conditions of Waste Water Treatment Plant - Town of Chatham

3.4 Village of Douglastown

The Village of Douglastown, located in the Parish of Newcastle in Northumberland County, is situated on the North bank of the Miramichi River about two miles east of the Town of Newcastle and about one mile west of the Town of Chatham. The core area of the village is on Highway 8, with Newcastle to the west, Fredericton to the southwest and Bathurst to the north. Highway 8 and the Miramichi Centennial Bridge connect the Village to the Town of Chatham.

Hutchinson Brook, a tributary to the Miramichi River, runs through the centre of the village. French Fort Brook flows westward across the undeveloped northern part of the village and then turns southward to form the boundary of the Town of Newcastle. The elevation varies from about 8 metres along the river front to 107 metres north of the French Fort Brook. The area is well drained except in the northern tip of the Village around "The Lake" area.

Because of its strategic position on the Miramichi River, Douglastown developed as a "company town" for the shipbuilding industry. With the decline of wood sailing schooners, Douglastown ceased to flourish and today remains essentially a suburban area for the Newcastle-Chatham communities. There are no local industries. Douglastown was incorporated as a village in 1966.

Population: An increasing population trend is observed in the village. According to census information, there was a 6% increase in population from the year 1976 to the year 1981. Douglastown has a population of 1091 residents in 323 dwellings. (1981 census)

YEAR	POPULATION
1971	637
1976	1032
1981	1091

Water Supply: Since 1979, the village has secured its water supply from two wells. The wells have depths of 105m and 135m and are equipped with alternating pumps each rated at 5 litres per second. One of the wells services the water distribution system while the second well supplies the 2.0 million litre capacity water tower. There are 365 service connections.

For the twelve month period June 1981 and June 1982, total water demand in the village of Douglastown was 126 million litres. Total daily consumption was 0.45 million litres per day. Considering the 1981 census population figure of 1091, the average daily consumption, therefore based on these figures is 318 litres per capita per day. The maximum water demand, according to the village superintendent of works, is 354 litres per capita per day. Four or five households are continuing to use private wells. Pump houses are located on Rennie Road and Williston Road. The distribution system consists of 305 metres of 36 cm ductile iron with the balance of the lines being pvc pipe. The village's supply is not metered, except at the wells. Figures (3.4) and (3.5) show well locations.

Records have been made of the village's water consumption since May 1981. Inconsistent pressure has been a problem in the far end of Kelly Drive. A booster pump is needed or, as suggested by the superintendent of works, it may be possible for households to run the municipal supply into their unused pressure tanks since private wells have recently been abandoned. In 1984, the water distribution system was extended.

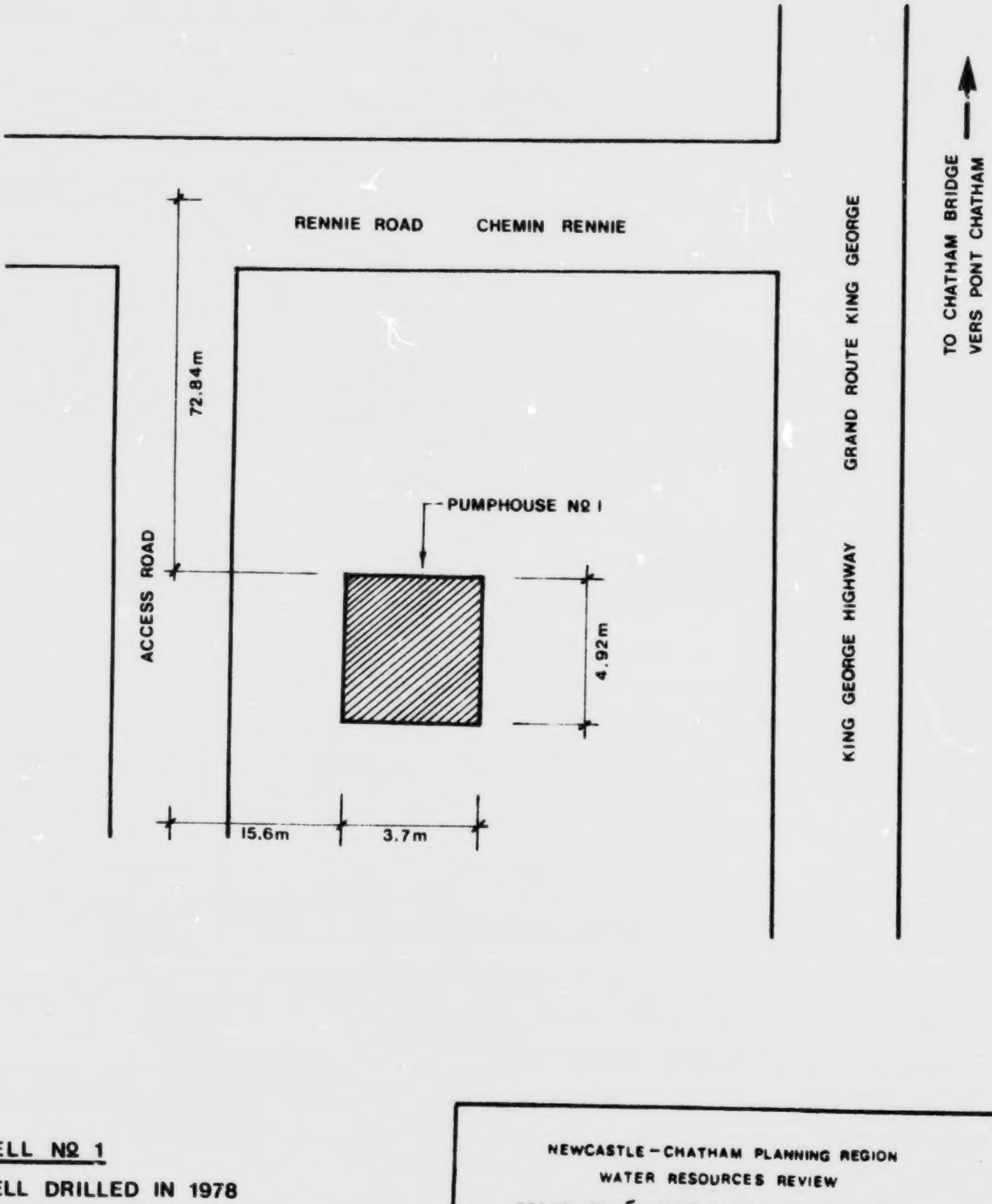
Water Quality: The quality of the municipal water is rated "excellent" by the village's superintendent of works. Provision has been made for chlorination if water quality demands it. Water quality surveys done by the N.B. Department of the Environment during the summer of 1982 indicate that the village's water supply is of good quality. Both municipal wells have high manganese levels, however. The well located off Rennie Road, showed manganese in excess of the maximum acceptable limit of 0.05 mg/l. Table (3.7) shows recent results of chemical analysis of the village well water.

Wastewater Treatment: An activated sludge aerated lagoon with a design capacity of 0.68 million litres per day is situated on the north side of Main Street (Highway 8) adjacent to Hutchison Brook. For the time period June 1981 to June 1982, the average daily flow at this treatment plant was 0.62 now 0.40 million litres per day. The treatment plant has a by-pass to the Miramichi River. Surface water infiltration is a problem for the village's sewage collection system during periods of intense rainfall. Four or five residences remain unconnected to the system. Table (3.8) show the results of the analysis of conditions of the wastewater treatment plant in the village of Douglastown.

Fire Protection: The village has 90 hydrants. One pumper and one tanker with combined capacity of 18,800 litres secure water from the municipal supply for fire fighting.

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


RENNIE ROAD CHEMIN RENNIE
72.84m
ACCESS ROAD
PUMPHOUSE Nº 1
4.92m
15.6m
3.7m
GRAND ROUTE KING GEORGE
KING GEORGE HIGHWAY
TO CHATHAM BRIDGE
VERS PONT CHATHAM

WELL Nº 1

WELL DRILLED IN 1978
SIZE OF CASING 20.32 cm
DEPTH OF WELL 38.1 m
CAPACITY 5.68 litres / sec

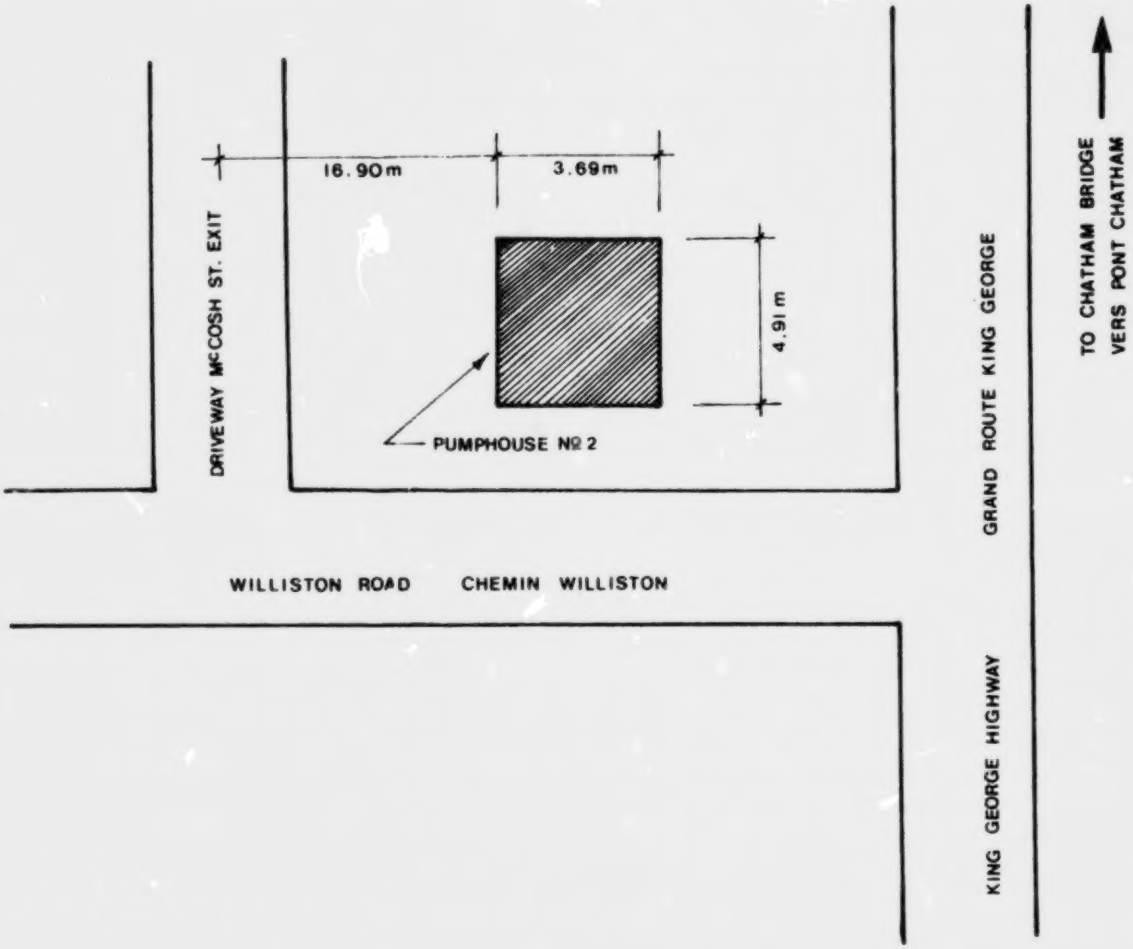
NEWCASTLE - CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE - CHATHAM
ETUDE DES RESSOURCES EN EAU

LOCATION OF WELLS
DOUGLASTOWN
REPLACEMENT DES PUITS

FIG. 3.4

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSORCES EN EAU


16.90m
3.69m
4.91 m
DRIVEWAY McCOSH ST. EXIT
PUMPHOUSE Nº 2
GRAND ROUTE KING GEORGE
TO CHATHAM BRIDGE
VERS PONT CHATHAM
WILLISTON ROAD CHEMIN WILLISTON
KING GEORGE HIGHWAY

WELL Nº 2
WELL DRILLED IN 1978
DEPTH OF WELL 41.15 m
SIZE OF CASING 20.32 cm
CAPACITY 5.68 Litres/sec

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

LOCATION OF WELLS
DOUGLASTOWN
EMPLACEMENT DES PUITS

FIG. 3.5

TABLE (3.7) CHEMICAL ANALYSIS FOR WELLS IN DOUGLASTOWN, N.B. (July, 1982)

PARAMETERS	UNITS	WELL #1 (Rennie Road)	WELL #2 (Williston Road)	TOWN HALL WATER	MAXIMUM ACCEPTABLE CONCENTRATIONS
Potassium	MG/L	.71	.70	.77	
Calcium		28.	28.	28.	200.
Flouride		L.1	L.1	L.1	1.5
Sulfate		7.8	4.6	7.6	500.
Nitrate-Nitrite		L.01	L.01	.02	10.
Alkalinity		87.	88.	86.	30 to 500
Conductivity	US/CM	190.	190.	200.	
pH	PHUNITS	7.85	7.84	7.87	6.5 to 8.5
Turbidity	NTU	L.1	L.1	L.1	5.0
Nitrite	MG/L	L.01	L.01	L.01	1.0
Sodium		6.2	5.9	6.0	270.
Iron		L.05	L.05	L.05	0.3
Manganese		.09 *	.05 *	.04	0.05
Copper		L.01	L.01	.08	1.0
Lead		L.05	L.05	L.05.	0.05
Zinc		L.01	L.01	L.01	5.0
Aluminum		L.1	L.1	L.1	
Chloride		L5.	L5.	L5.	250.
Silica		17.	15.	17.	
Magnesium		2.5	2.6	2.5	150
Hardness		80.208	80.62	80.208	120

L - Less Than
* - Concentration exceeds guidelines for Canadian Drinking Water Quality 1978

ACTIVATED SLUDGE WASTEWATER FACILITY
USINES D'EPURATION A BOUE ACTIVEE

Municipality
Municipalité DOUGLASTOWN

Capacity
Capacité 0.15 M.I.G.D.

Type of process AERATION ETENDUE
Genre de procédé EXTENDED AERATION

Design population
Population de design 3000

Operator
Opérateur SAM SHIRLEY

Major industries
Industries majeures

Average values obtained
Valeur moyenne obtenues

Year Année	BOD/DOB (mg/l)		SS/MS (mg/l)		TKN/ATK (mg/l)		TPO_4 (mg/l)		MLSS/ MSLM (mg/l)	MLVSS MVSLM (mg/l)
	in	out	in	out	in	out	in	out		
1981	160	L10	103	19	35	2.2	20	13	6233	3766
1982	151	23	94	14	18	2.6	9.8	7.6	5071	3574

Table (3.8) Analysis of Conditions of Wastewater Treatment Plant
Village of Douglastown

3.5 The Village of Loggieville

The Village of Loggieville is situated on the south bank of the estuarine Miramichi River. The main access routes to the Town of Chatham, which is located 9 km upstream of the village, are Highway 117 and Shore Road. Highway 117 extends southeastward along the coast through the Kouchibouguac National Park to connect to Highway 11 at Kouchibouguac.

Historically, Loggieville was developed because of its sheltered location for the fishing and shipbuilding industries along the Miramichi River. The changing economy and the new modes of transportation in the Region have gradually shifted the emphasis. Today, only the fishing industry survives and is the main economic activity in the community. The village is becoming more of a suburban satellite to the main Chatham-Newcastle communities. The settlement pattern in the village is typical of all rural settlements with the fishing plant and wharf in the core area and residences sprawled along major roads. Loggieville was incorporated as a village on November 1966.

The land within the Village boundary is flat and low lying, varying from a metre or so along the water front at Washburn Beach to about 22 m above mean sea level on the southwest corner of the Village. Two brooks flow through the village boundaries. Black Brook drains northeastwardly across the centre of the Village while Murdoch Brook forms a portion of the eastern boundary of the Village. Both brooks discharge into the Miramichi River. About one-third of the area, found mainly on the south side of the Village between Black Brook and Murdoch Brook is marshy.

The village proper is underlain by varying but generally thin overburden deposits of a sandy clay nature. Inland from the village, large thicknesses between one to six metres of brown clay are encountered. This may indicate an old river channel. Beneath the consolidated deposits are a series of grey sandstones, grey and red shales and grey clays. They vary considerably in thickness and appear for the most part, to be discontinuous.

Population: The population trend in recent years in Loggieville has been relatively stable. The 1981 census records 781 persons in 220 occupied dwellings.

CENSUS YEAR	POPULATION
1951	809
1956	846
1961	691
1966	855
1971	877
1976	784
1981	781

Water Supply: Since individual private wells are the source of supply, there is no historical record of domestic water consumption by the village. An estimated daily per capita consumption of 455 litres per day (ABP Consultants, 1980) seems high in view of the fact that a similar Miramichi community, Douglastown, is known to use 318 litres per capita per day (this report). There are no commercial or industrial water users in the village.

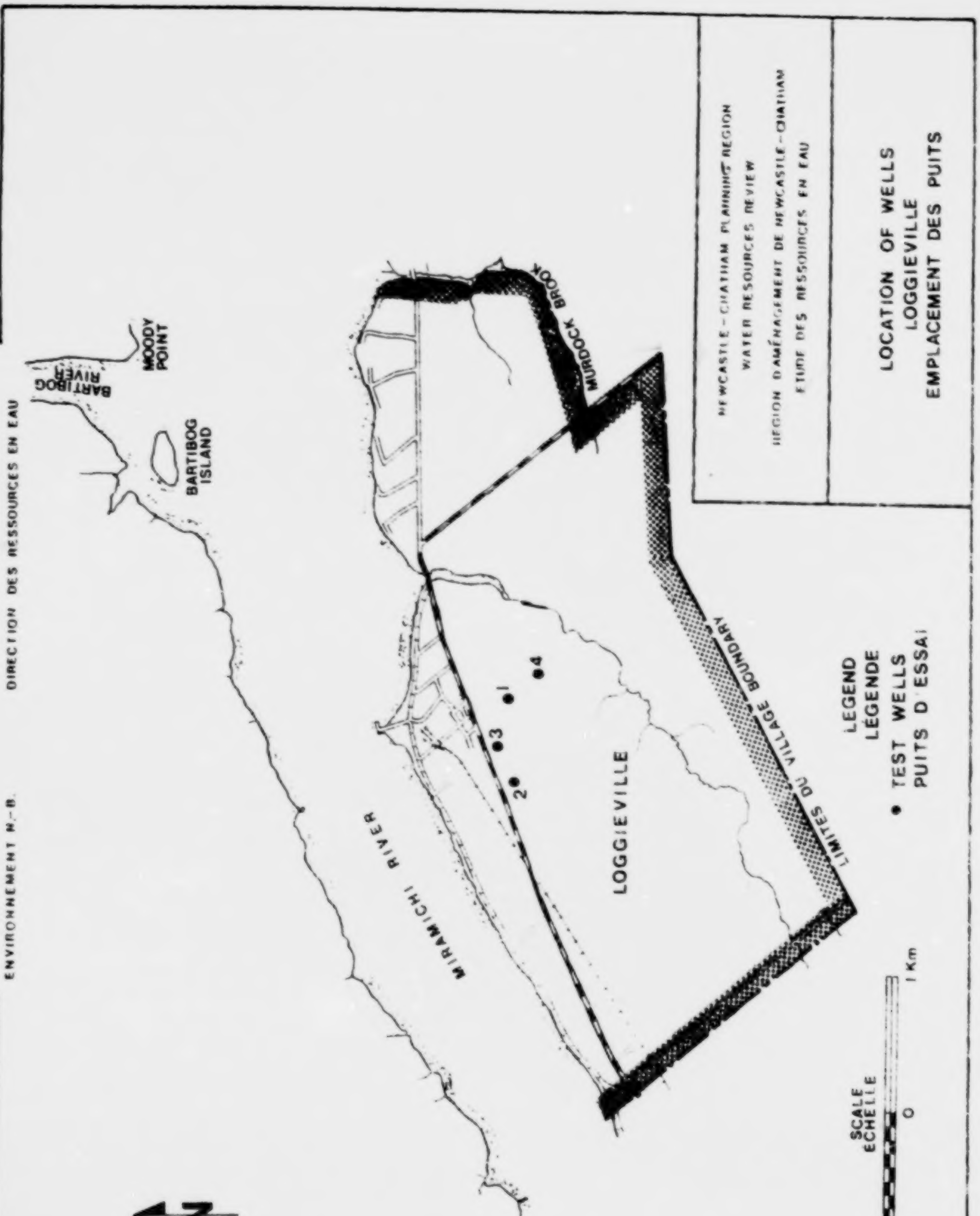
Shallow private wells, usually no more than nine to twelve metres, supply Loggieville's domestic water needs. Recently, twelve new wells ranging in depth from 7.5 to 45 m have been drilled. Four of these new wells replaced older wells that have gone dry.

The village has known water quality problems. An odor and high iron concentration are the user's main complaints. Some private wells do not satisfy the Canadian Water Standards for quality due to high iron and manganese concentrations, (APB Consultants, 1980). Salt is also a potential problem in this locality due to the high fractured nature of the rock and the proximity of the estuary.

In 1980, preliminary exploration and testing for a water supply for the Village of Loggieville was conducted in the area south of Highway 117 and west of Manse Street. The most promising water supply of good quality in 3 of the 4 test wells drilled occurred at depths between 30m and 76m. Chemical analysis of samples taken from the test wells showed iron and manganese to be well below the acceptable limits. The levels of chloride were low and reached a maximum of only 16.9 ppm. The sodium and bicarbonate concentrations were higher than normally found in potable waters. (ABP Consultants, 1980). See Figure (3.6) for location of test wells and Table (3.9) for Water Quality Analysis, 1980 Loggieville.

In order to ensure an adequate water supply for Loggieville, the consultants concluded that any future well development should occur approximately 60m inland of Highway 117 and west of Manse Street in Loggieville. Two 20 cm wells, of no more than 76m depth, spaced 90m apart and pumped at 4.5 - 5.3 l/s so as not to extend the cone of depressions under the estuary and increase the likelihood of salt intrusion. In test pumping, consultants found the approximate cone of influence to reach out under the estuary after 72 hours of pumping at 7.6 l/s. There were also indications of a partial dewatering effect on the observation well.

Although the calculated safe yield of the test wells is approximately 23 l/s, the presence of the estuary and its salt water and the presence of a potential barrier which may be large thicknesses of clay, indicating an old river channel parallel to the coastline, would reduce this yield. The similarity of transmissivities for the pumped


ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.
WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU
NEWCASTLE–CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE–CHATHAM
ETUDE DES RESSOURCES EN EAU
N
BARTIBOG RIVER
MOODY POINT
BARTIBOG ISLAND
MIRAMICHI RIVER
LOGGIEVILLE
MURDOCK BROOK
VILLAGE BOUNDARY
LIMITES DU VILLAGE
1
2
3
4
LEGEND
LÉGENDE
● TEST WELLS
PUITS D'ESSAI
SCALE
ÉCHELLE
Metres 1000
0
1 Km

LOCATION OF WELLS
LOGGIEVILLE
EMPLACEMENT DES PUITS

FIG. 3.6

TABLE (3. 9) WATER QUALITY ANALYSIS, 1980 - LOGGIEVILLE (ABP CONSULTANTS LTD., 1980)

Parameters	Maximum Acceptable Concentration	Well #1	Well #2	Well #3	Well #4
Alkalinity (mg/1)	30	110	72	170	73
Color	15	-	70	-	-
Hardness (mg/1)	200	99	-	-	-
Odour	-	-	-	-	-
Ph	6.5 - 8.5	-	6.8	8.3	8.0
Taste	-	-	-	-	-
Turbidity	5	-	22	-	-
Total Dissolved solids (mg/1)	500	-	-	410	-
Calcium (mg/1)	200	-	24	18	23
Bicarbonate (mg/1)	no recommended limit				
Carbonate (mg/1)	no recommended limit				
Chloride (mg/1)	250	1.7	-	26	2
Copper (mg/1)	1.0	-	-	-	-
Flouride mg/1)	1.5	0.2	0.1	1.7	0.1
Iron (mg/1)	0.3	3.4	6.6	5.5	0.1
Magnesium (mg/1)	150	6.1	-	-	-
Manganese (mg/1)	0.05	0.3	1.6	0.4	0.2
NO_3 NO_2 (mg/1)	10	-	-	-	-
Pnenols (mg/1)	0.002	-	-	-	-
Potassium (mg/1)	no recommended limit	4.7	0.6	3.1	2.1
Sodium (mg/1)	270	6.5	5.9	140	3.8
Sulfate (mg/1)	500	-	-	-	-
Sulphide as H_2S (mg/1)	0.05	-	-	-	-

well and observation wells may indicate an extensive aquifer which has a generally uniform ability to transmit water. The low recovery of the observation well, however, suggests the necessity for reducing the safe yield. (See ABP Consultants, 1980 for details).

Wastewater Treatment : Sewage disposal in the village is by means of private septic tanks and cesspools. The effluent of the sewage systems is directed eventually to the Miramichi River.

The village's lack of public sewage collection and treatment services combined with the use of shallow wells for domestic water supply presents a possible health hazard. Possible contamination of wells and pollution of the Miramichi River by partially treated sewage, as well as the presence of exposed drain outlets are all reasons to persuade a community to consider the installation of a municipal sewerage system. However, in July, 1982 the Village Council voted against installing a municipal sewerage system. The state of the economy and the fixed incomes of the employed population is cited as the reason for their decision. The municipality later decided to install a municipal sewerage system and in April 1983, Village Council voted in favour of the proposal and construction began that summer.

There are no major commercial or industrial water users in Loggieville.

Fire Protection: One pumper truck with a capacity of 73,000 litres provides fire protection for the Village. Water for fire fighting is drawn from the Canadian National train watering system - a 150 mm well pumping into a 7.5 cubic metre holding tank.

Flooding: There is no history of flooding in the Village proper. However, during times of strong northeasterly winds, storm,or tide surges, have damaged boats and wharves in the area and traffic on the Shore Road between Chatham and Loggieville has been interrupted because of high water levels.

3.6 The Village of Nequac

The Village of Nequac is located on Route 11 on the North Shore of Miramichi Bay in the Parish of Alnwick, Northumberland County.

Nequac, the largest village within the planning region, has experienced a continuing population increase over the past decade. The population is 1,755 and there are 455 dwelling units within the municipality. Census figures are:

YEAR	POPULATION
1971	1498
1976	1733
1981	1755

The main development has been along a four mile section of Route 11. Commercial development is located throughout the length of the village. However, there remains only one industry in this community - Albert & Sons, a processor of marinated herring, employing approximately 100 persons.

The general topography of this village area is flat with gentle sloping land to the Bay. Side street gradients are never more than 2%.

Water Supply: The water supply in Nequac is from private wells. Ground water is readily available in this municipality and well depths vary from 4 metres to 90 metres. The average private well depth is between 18 to 30 metres. The community's only major employer, Albert & Sons has a private ground water source. The well depth is 30 metres.

Water Quality: The water quality in the village of Nequac is described by the town manager as being "poor", especially in the area from L'eglise Street to Sullivan Street. Some residents object to the "boggy odor" and sometimes "rusty" appearance of their water supply. Others suspect some well supplies, for example the village office well, of being polluted, prefer not to drink this water and secure drinking water from other wells.

Wastewater Treatment: The disposal of sewage is a problem for residents of Nequac. The low percolation rate and high water table particularly in the spring of the year, are suspected by village officials of causing the pollution of some wells. This is the case with the well supply which services the Village's Municipal Office. The restriction of ground percolation from septic tanks in this area results in an overflow into open ditches. This presents a potential health hazard during times of heavy surface runoff or times of freshet.

Ditches and culverts are not able to control the surface flow in some areas along Route 11 and back water flooding has occurred. High groundwater levels interfere with the performance of septic fields particularily near Fair Isle Road area.

There are two small sewage treatment plants within the village. One services the needs to the local school. Effluent from this plant flows directly into the Bay. The second plant serves a ten-unit low rental district near Fair Isle Road. The effluent flows into the nearby brook and thence into the Bay. The Medical Health Centre shares this waste treatment facility. The existing private septic systems are unable to accommodate the needs of a growing modern community. The lack of adequate percolation and potential pollution of nearby well fields is a problem that has yet to be addressed by the village council.

In 1974, an engineering consultant prepared a study and preliminary plans for a water and sewer service in the Village of Neguac (Harwood, 1974). The need for municipal sewage disposal was seen as being most critical.

The report also suggested a 0.9 million litres water storage standpipe be erected at the intersection of William Gay Road and Peter Road. This storage would serve as core area providing a nucleus for future expansion of distribution system.

Fire Protection: Fire Protection is provided by one 3600 litre pumper truck and a (4500 litre tanker), and water is secured from a brook next to the Fire Station. The proposed reservoir (Harwood, 1974) would provide a fire flow of 76 litres per second for 2 hours, at a residual pressure of 1.4 kg/sq. cm. This meets the N.B. Board of Underwriters' requirements for most residences, small apartment buildings, unexposed and most small unexposed commercial buildings. The storage capacity required to meet a fire flow for some of the larger buildings, i.e. 227 l/s for 3 hours, would be uneconomical for this particular community. In general, this recommended volume of stored water will enable the Fire Department to provide much improved fire protection throughout the whole village.

3.7 The Village of Nelson-Miramichi

The Village of Nelson-Miramichi is situated on the south bank of the Miramichi River where the North-West and South-West branches join the main river. It is located in the Parishes of Nelson, Chatham and Glenelg in Northumberland County. The Town of Newcastle is situated on the opposite side of the river and the Town of Chatham is about 8 km downstream. The Village is connected to Newcastle by the Morrissey Bridge,to Chatham by Highway 118, to Fredericton either through Highway 118 or Highway 8 and to Moncton by Highway 126. Carding Mill Brook via Flett Cove and Meadow Brook flow across the centre of the village to the Southwest Miramichi River. The land is well drained except at a few localities in the vicinity of Carding Mill Brook.

The village was incorporated as a municipality on October 2, 1967. The village's location on the Miramichi River front, its accessibility to the river and a direct connection to Newcastle by way of Morrissey Bridge,have developed Nelson-Miramichi into an "industrial" village centered on Acadia Pulp and Paper Limited and the now closed Geo. Burchill Limited. There are two residential clusters or precincts separated by Acadia Pulp and Paper Limited along the river front. Although the village incorporates many settlements, the village core appears to centre on the former South Nelson settlement.

Surface elevations throughout the village range from sea level to approximately 38 metres above sea level. The village has an area of approximately 2750 hectares. The overburden varies in thickness but is generally only a few feet of brown clay. The bedrock consists of various thicknesses of alternating red and grey shales and grey sandstone. Most of the village is underlain by low yield shale rock which seems to dominate over sandstone at least to a depth of 70 metres (Godfrey Associates Ltd., 1980).

Population: The settlement of South Nelson showed a population growth for the period 1951-1961, but a slight decrease in population during the period 1961-1966. In the settlement of South Nelson Road, the period of peak population occurred in 1951-1956, but in 1961 the population had dropped from 330 in 1956 to 240 with an average annual negative growth rate of 8 percent. The 1981 census population of the Village of Nelson-Miramichi is 1452, which represents a six percent decline since 1976. The total number of occupied dwellings (1981 census) is 388 with the average household numbering 3.71 residents.

Water Supply: The village's domestic water is secured from private wells with average depths between 15 metres and 46 metres. Except for excessive manganese and iron concentrations, the quality of groundwater is described as good. A village official suggests that two wells have "a little salt" and during periods of heavy runoff water quality is "poorer". However, pumping of these wells has reduced the salt problem.

Preliminary exploration and testing for a water supply in the Village of Nelson-Miramichi, was conducted by Water Management Services Ltd. in early 1980. A total of six test holes varying in depth from 61 to 107 metres were drilled. Varying amounts of of water were located. The average yield of test holes located beneath the village proper would appear to be 0.4 l/s - 3 l/s in the upper 61 metres of the bedrock. Consultants (Godfrey Associates Ltd., 1980) suggest that the potential yield of a well field developed for the Village of Nelson-Miramichi should be in the range of 11 - 19 litres per second.

The test well hole located in the gravel pit on the Rogersville Road, the only area which showed an acceptable quantity of water, indicated a safe yield of 10 litres per second which would appear to be a marginal rate. The transmissivity of this well location is 129 sq. m/day. This area is the location recommended by the consultants for future village well field locations. See Figure (3.9) for test well locations.

Wastewater Treatment: During the summer of 1982, a sewage collection and treatment system was installed in Nelson-Miramichi and neighboring Chatham Head, a Local Service District.* The oxidation pond is on the Chatham Head shoreline near Canadian Point and this site will accommodate both Nelson-Miramichi and Chatham Head's domestic waste treatment needs. Three lift stations have been installed in Nelson. A three hectare and a four hectare lagoon located on 9 hectares of land will serve a design population of approximately 1100 people. There are about 577 service connections of which 417 are presently installed. There are 66 vacant lots. Approximately 94 dwellings are not connected to the sewer system. Most of the Nelson-Miramichi serviced area will not have storm sewers installed except for Station Street and a section of Main Street. Outflow is directed to the Miramichi River.

The only major industry in this municipality, the Acadia Pulp and Paper Limited, secures its water supply for processing from private reservoirs on the Moss Pond and Carding Mill Brook. Filter stations are located at the plant. Average daily consumption is 79 - 84 litres per second. Potable water is a ground source. Details are unknown.

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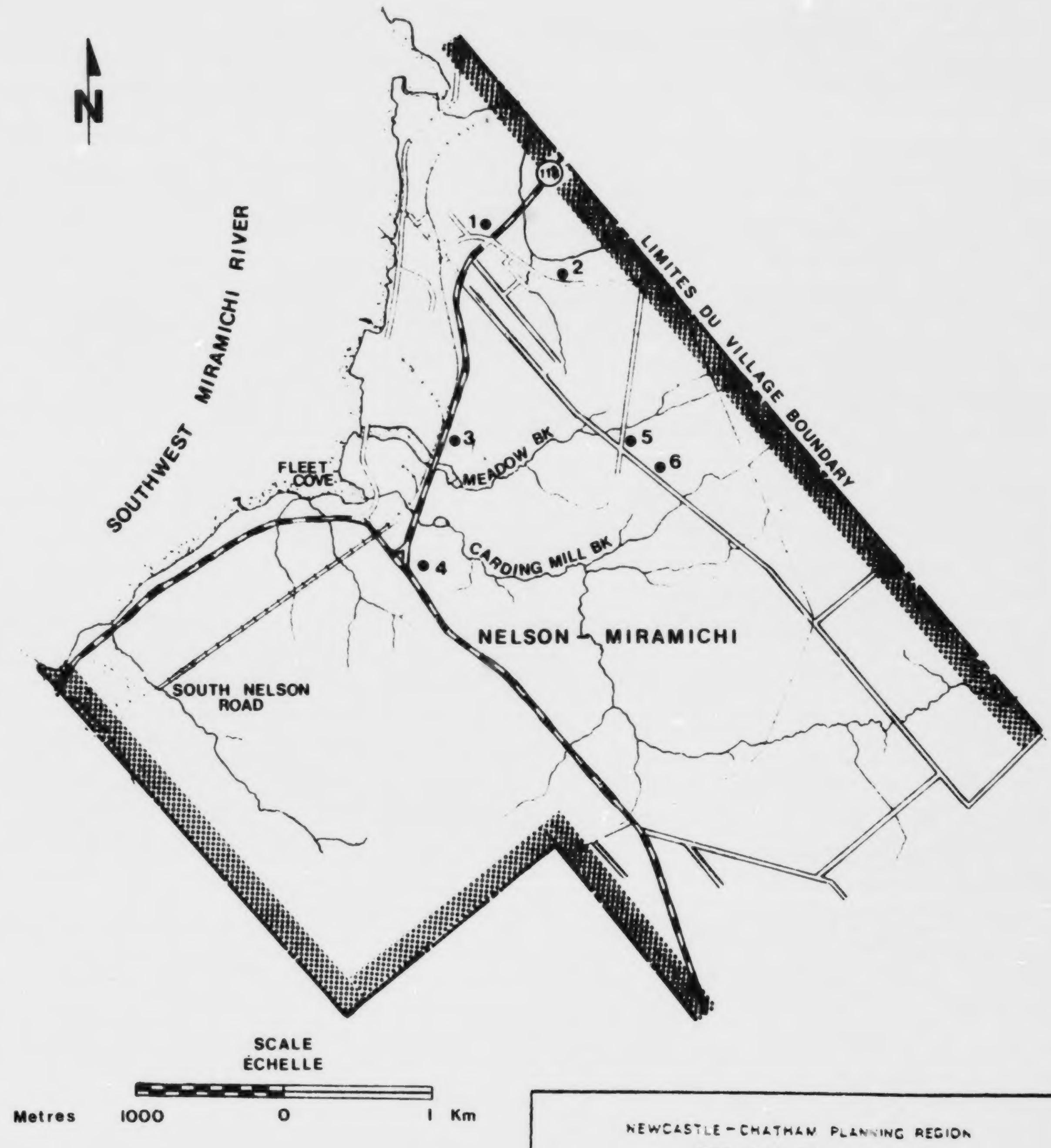
*Servicing plans prepared by Godfrey Associates Ltd.

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU


N
118
SOUTHWEST MIRAMICHI RIVER
LIMITES DU VILLAGE BOUNDARY
1
2
3
5
6
4
FLEET COVE
MEADOW BK
CARDING MILL BK
NELSON - MIRAMICHI
SOUTH NELSON ROAD
SCALE
ÉCHELLE
Metres 1000 0 1 Km

LEGEND
LÉGENDE

● TEST WELLS
PUITS D'ESSAI

NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

WATER SOURCES
NELSON - MIRAMICHI
SOURCES D'EAU

FIG. 3.7

Fire Protection: Three tanker trucks draft water from the brooks in the Craigville and Nowlanville area. Most of the water supply for firefighting purposes is secured from the Acadia Pulp and Paper Co. Ltd.

3.8 The Town of Newcastle

The Town of Newcastle is situated on the North Bank of the Miramichi River in the Parish of Newcastle, Northumberland County. Highway 8 passes through the center of town with Fredericton to the southeast and Bathurst to the north. Newcastle is connected to Moncton by way of Highway 126 and the Halifax-Montreal mainline of the Canadian National Railway.

Two of the tributaries of the Miramichi River, the French Fort Brook and Cove, and the Oxford Brook and Jones Cove respectively form the northern and southern boundaries of the Town. The elevation varies from 8 metres at the River to 53 metres in its northwestern section near the Canadian National Railways station. The land is well drained except at two localities; a small swampy area north of the highest point and the Strawberry marsh in the vicinity of the confluence of the two main tributaries, the Northwest and Southwest Miramichi Rivers. The Miramichi River at Newcastle is tidal with a tidal range of approximately 1.4 meters.

Newcastle is a northern New Brunswick depot for Irving Oil Company Limited and the Imperial Oil Limited. There are a number of industries of various sizes within the Town limits. The largest is a wood pulp industry, Miramichi Timber Resources Limited, located on Highway 8 bordering the Miramichi River. The pulp wood lumber industry, N.S. Anderson Company Limited which has its lumber yard on the east side of the Canadian National Railway track and south of the Morrissey Bridge ,has ceased operations.

Population: During the period between 1951-1961, the rate of population expansion of the Newcastle area exceeded that of the Province of New Brunswick. During 1961 to 1966 the growth rate dropped to a low of 0.2 percent. The 70's decade was accompanied by what regional developers optimistically refer to as "a pause" in the Miramichi regions economic development and growth. Between the years 1961 to 1971 the labour force in Northumberland County increased by over 18% but the net migration from Northumberland County since 1961 has been persistent. With the recent shut-down and closure of many of the area's forest based industries, and the consequences of a world wide recession affecting the mining sector, forecasts based on constant growth rate has resulted in over-forecasting and overestimating per capita demand of existing municipal water supplies. Projected population for Newcastle for the years 1980 and 1981 have ranged from 7,240 to 8,000. Census figures record Newcastle's population in 1981 as 6,284 with a total of 2,057 occupied dwellings.

YEAR	POPULATION
1941	3,781
1951	2,248
1961	5,236
1966	5,911
1971	6,460
1976	6,423
1981	6,284

Water Supply: The Town of Newcastle secures water from groundwater resources. There are a total of six wells servicing the water system, two wells (average depth 30 metres) are operational and four are used as stand-by or back-up wells. Pumping of the wells is not continuous. The information presented in Table (3.10) indicates an average daily demand of 4.82 million litres per day. Recently, consumption has averaged 4.5 million litres per day. Three residences still have private wells.

Boise-Cascade is one of two major industries within the area using the towns water supply. Consumption by this industry of potable water is 0.15 million litres per day. This supply supplements the company's own private source which is used for industrial processing and amounts to approximately 76 million litres per day.

The town's major industrial user, Domtar, was not metered until the summer of 1982. During that period of time, Domtar used approximately 0.55 million litres per day, an amount which probably exceeds that needed for drinking purposes and fire fighting supply. Apparently there is no check valve on the water distribution line at Domtar. This is of concern to the municipal works department. The Company has two privately owned 36 metre deep wells equipped with submersible pumps but no water consumption figures are available for these.

The town hospital is the major institutional user of municipal water. Consumption was metered during the time period July 1981 to July 1982 at 0.11 million litres per day.

The Canadian National Railway used 49 million litres during the year 1983, a reduction from 97 million litres in 1981. Ships are supplied with water from the municipal system. An average ship takes 90,000 litres of water. Over 70 ships visit the port each year.

Subtracting major industrial and institutional consumption from total daily pumpage results in a domestic water consumption of about 3.74 million litres per day. Therefore, with a population of 6,284 persons, the daily domestic per capita consumption in Newcastle can be calculated to be

TABLE (3.10) DETAILS OF PRODUCTION WELLS IN NEWCASTLE*

NAME OF WELL	YEAR IN PRODUCT-ION	TYPE	DEPTH m	DIAMETER cm	CAPACITY L/sec	COMMENT
Mitchell St. Pump #1	1902	Surficial		15	32	Standby
Mitchell St. Pump #2	1978 or 1981	Surficial	37	25	32	Main Continuous (23 hours)
Geirie Pump #3 (Mitchell St.)		Surficial	45	15	25	Back-Up
Reservoir Pump #6 (Chapin Island Rd)	1902	Bedrock		15	16	
Miller Pump #4	1975 Drilled	Bedrock		15	25	Pumping once a day at peak demand
Reid	1963	Bedrock	85	25	13	Idle (fire protection)
Rogers	1963	Bedrock	153	25	16	Dismantled in 1976

Pumps 1,2,3,6, feed 115,000 imp. gallon reservoir and low pressure distribution system
Pumps 4,5, feed 600,000 imp gallon standpipe and high pressure distribution systems.

*Units are converted to metric

approximately 600 litres. (See Table 3.11). This is a relatively high rate when compared to the provincial average per capita consumption of about 400 litres per day. Poorly installed water mains and house connections have resulted in leakage from the water distribution system.

Water Quality: The water quality of the town's supply is described as 'good' by the superintendent of works. The chemical analysis of Newcastle's water supply is presented in Table (3.12). Manganese concentrations in water from six municipal wells exceed the maximum acceptable limits set by the Canadian Drinking Water Quality, 1978. Elevated manganese content in water may cause aesthetic quality problems such as staining of fixtures and laundry, but it is not a health problem.

Water Distribution: Water distribution is by way of 10 to 30 cm cast iron or ductile iron water mains. Much of the system is gravity fed from a 3.4 million litre standpipe This reservoir serves the north and northeast sectors of the community east of Mullin Street. A 2.7 million litre storage reservoir is located north of Riverview Drive and supplies the 'lower town'. Recent changes in the distribution system include an automatic pump, low level alarms and indicator lights at the pump house. There have been no major leaks in the system for the past two years. Line pressure in the distribution system is between 5 - 6 kg/cm^2. Pressure in the industrial park area is 4 kg/cm2.

Recent development within the town is occurring 'up the hill' and the location of the present back-up well appears to be neither cost nor energy efficient. However, the town's lack of additional pump needed to maintain the volume and pressure from the reservoir which services the 'upper end of town' is an economic consideration. The town's superintendent of works suggests there may be excessive wastage, mainly in new subdivisions. Recently, more water lines have been installed to the industrial park.

Waste Water Treatment: Wastewater treatment in Newcastle consists of an oxidation ditch equipped with a 40 foot circular secondary clarifier and a continuous sludge return with optional chlorinator. This plant was designed for a population of 8,000 persons and has a design capacity of 3.77 million litres per day. There is no flow measuring device in the plant but the average flow-through is about twice the design capacity (plant operator). A two foot pipe bypass carries excess flow to the Miramichi River. During heavy rains, the bypass is too small to control the effluent. Because of lack of storm sewers, the rate of infiltration taxes the capacity of the sanitary sewers and contributes to excess flow through the treatment plant during periods of high runoff. In 1984, extensions to the sanitary sewer system for Centre Scolaire and Ideal Court were completed. Consideration is being given to the overhaul of the sewer system.

TABLE (3.11) WATER CONSUMPTION DATA-TOWN OF NEWCASTLE

Total Demand	4.82 mill litres/day
Domtar	0.55 mill litres/day
Boise Cascade	0.15 mill litres/day
CNR	0.27 mill litres/day
Hospital	0.11 mill litres/day
Total Domestic Demand	3.72 mill litres/day
Population	6,284
Total Per Capita Demand	800 Litres/day
Domestic* Per Capita Demand	600 Litres/day

*Excluding major industrial, commerical and institutional users only.

Table (3.12)WATER QUALITY OF WELLS IN THE TOWN OF NEWCASTLE (JULY, 1982)

CHEMICAL TEST	Mitchell Street Well #1	Mitchell Street Well #2	Mitchell Street Well #3 (Geikie)	Mitchell Street Well #4 (Miller)	Chapin Island Road Well #6 (Reservoir)	Town Hall Water	Maximum Acceptable Limits	
							Concentration	Units
Potassium	1.2	1.2	1.4	2.2	.94	1.2	---	mg/1
Calcium	32.	33.	36.	46.	26.	32.	200.	
Flouride	L.10	L.10	L.10	L.10	L.10	L.10	1.5	
Sulfate	25.	24.	26.	18.	14.	25.	500	
Nitrate	L.01	L.01	L.01	L.01	1.4	L.01	10.	
Alkalinity	101.	100.	92.	89.	47.	100.	30 to 500	
Conductivity	390.	386.	480.	450.	263.	400.	---	us/cm
pH	8.0	7.3	8.0	7.9	6.7	7.9	6.5 to 8.5	NTU
Turbidity	.23	.18	.25	.19	.06	.05	5.0	mg/1
Nitrite	L.01	L.01	.01	.01	.01	.01	1.0	
Sodium	35.	35.	43.	20.	12.	35.	270.	
Iron	.05	.05	.05	L.05	L.05	L.05	0.3	
Manganese	*.25	*.23	*.20	*.09	.04	*.22	0.05	
Copper	L.01	L.01	L.01	L.01	.01	.03	1.0	
Lead	L.05	L.05	L.05	L.05	L.05	L.05	0.05	
Zinc	L.01	.03	.02	.04	L.01	.01	5.0	
Aluminum	L.10	L.10	L.10	L.10	L.10	L.10	---	
Chloride	36.	37.	64.	63.	30.	37.	250.	
Silica	14.	13.	14.	13.	14.	14.	---	
Magnesium	3.6	3.6	4.5	7.9	4.4	3.6	150.	
Hardness	94.725	97.222	108.418	*147.386	83.037	94.725	120.	

*Indicates greater than acceptable limit set by Canadian Drinking Water Quality, 1978

Source: Water Resources Branch, N.B. Department of the Environment

ACTIVATED SLUDGE WASTEWATER FACILITY

USINES D'ÉPURATION À BOUE ACTIVÉE

Municipality
Municipalité NEWCASTLE

Capacity
Capacité 0.832 M.I.G.D.

Type of process FOSSÉ D'OXYDATION
Genre de procédé OXIDATION DITCH

Design population
Population de design 8320

Operator
Opérateur EDWARD McKEIL

Major industries
Industries majeures

Average values obtained
Valeur moyenne obtenues

Year Année	BOD/DOB (mg/l)		SS/MS (mg/l)		TKN/ATK (mg/l)		TPO_4 (mg/l)		MLSS/ MSLM (mg/l)	MLVSS MVSLM (mg/l)
	in	out	in	out	in	out	in	out		
1980	54	10	59	10					1700	1190
1981	65	10	67.3	12.2	11.3	1.9	8.9	10.1	1333	877
1982	75	L10	48	10	11.1	3.1	11.5	5.8	1380	987

Table (3.13) Analysis of operating conditions of wastewater treatment plant - Town of Newcastle

Flooding: During the flood event of 1970, the drinking water was contaminated in Newcastle. The wells were apparently not sealed correctly. Town officials are confident that this danger has been eliminated. The town dump was moved from the Strawberry Marsh to Douglastown a few years ago, but refuse from the original location is reportedly running into the river. Other sources of pollution in the event of a flood in the Newcastle area include Newcastle sewage treatment lagoon on the Strawberry Marsh; waste from the wharves of the two major mills, as well as the old sawdust piles of the Anderson Mill (Castle Street); and the Irving Oil Limited Storage tanks on the Newcastle Waterfront. According to residents of the Newcastle area, pollution controls by the mills are seldom adhered to. The potential for possible pollution would definitely increase in the event of a flood (Nicholson, 1982).

Fire Protection: Newcastle's fire protection includes 256 hydrants which yield 0.91 million litres per day. Number three well is sometimes used to supply water for forest fires.

3.9 The Village of Rogersville

The Village of Rogersville is situated in the Parish of Rogersville, Northumberland County, bordering Kent County. It is located on the main access highway 126 between Chatham in the north and Moncton in the south.

The village is fairly flat with the lowest elevation of about 70 m in the northern corner of the East Barnaby River to over 91.4 m in the center of the village. Patches of marshy areas are found on the west side of the Village. The settlement pattern of the village is basically sprawled along highway 126, which parallels the railway and highway 440. Other village streets are tangential to this main strip. See Figure (3.10) for sketch of municipality.

In 1869, when the Intercolonial Railroad between Halifax, Quebec City and Montreal was constructed, Rogersville settlement was founded. The Village of Rogersville has two resource industries, agriculture and forestry. Recently, outlying agricultural land has been used for the growing of Brussel Sprouts. Rogersville is well known for its religious background. The religious institutions, Trappists and Trappistine's and the historic religious shrine are a major tourist attraction. Rogersville was incorporated as a village on November 9, 1966.

Population: Rogersville shows an increasing population trend. The 1981 census population of 1237 shows a nine percent increase over 1976 population of 1138. A 6% increase from 1971 was recorded in 1976 census. There are approximately 363 dwellings with each dwelling housing approximately 3.15 residents.

YEAR	POPULATION
1971	1077
1976	1138
1981	1237

Water Supply: Private wells supply the Village of Rogersville with its domestic supply. Generally these wells range in depth from 10 m to 26 m. Deeper wells of 38 m to 46 m are exceptional. In June 1982, a 30 m deep well was drilled to supply the new Senior Citizen Complex, yielding 45 l/s.

According to Village officials, deeper wells have a problem with high mineral content. Many residents use water softeners.

Wastewater Treatment: Rogersville has a sanitary sewerage system discharging into a two cell operation lagoon. In 1969, 75% of the community waste water was being treated. By 1976, there was 97% treatment. Six or seven dwellings are excluded from the sewage system. The effluent from the lagoons discharge into the East Barnaby River and into the Barnaby River. See Tables (3.14) and (3.15) for the most recent analysis of operating conditions.

Fire Protection: The village's fire protection water supply is secured from two wells, the C.N.R. well and a local well which yields 7.6 l/s.

BASSIN DE STABILISATION
WASTE STABILIZATION POND

MUNICIPALITE / MUNICIPALITY: Rogersville #1

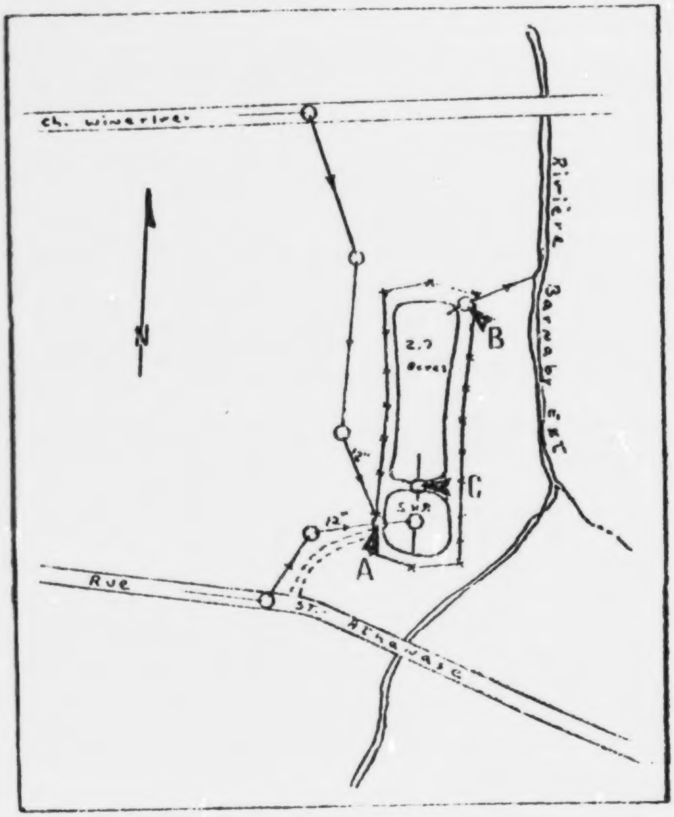
POPULATION: 1237

SURFACE DU BASSIN / POND AREA: aeré/aerated

CHARGE Kg/JOUR / LOADING Kg/DAY: 111.2

MISE EN OPERATION / BEGINNING OF OPERATION: 1978

INDUSTRIES MAJEURES / MAJOR INDUSTRIES:



Valeurs médianes obtenus depuis 1979
Median values obtained since 1979

	BOD/DBO		SUSPENDED SOLIDS MATIERES EN SUSPENSION		TOTAL PHOSPHORUS PHOSPHORE TOTAL		TKN/ATK	
	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)
1979	101	30	140	98	7.3	5.3	36.0	13.0
1980	90	22	158	57	5.7	4.0		
1981	90	26	85	28	4.1	4.3	16.8	14.5
1982	190	36	138	34	8.0	5.3	38.0	13.0
*	95	31	97	34	5.0	4.0	31.0	13.5

(Table 3.14)

* Valeurs médianes obtenues les 3 dernières années.
Median values obtained over the past 3 years.

BASSIN DE STABILISATION
WASTE STABILIZATION POND

MUNICIPALITE
MUNICIPALITY Rogersville #2

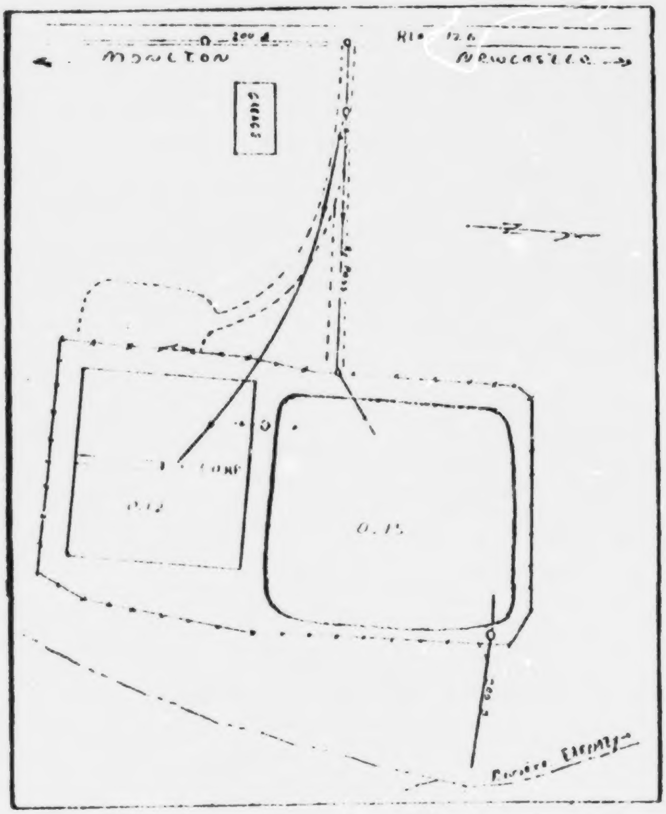
POPULATION 1237

SURFACE DU BASSIN
POND AREA

CHARGE Kg/JOUR
LOADING Kg/DAY 15.3

MISE EN OPERATION
BEGINNING OF OPERATION 1980

INDUSTRIES MAJEURES
MAJOR INDUSTRIES



Valeurs médianes obtenus
Median values obtained

	BOD/DBO		SUSPENDED SOLIDS MATIERES EN SUSPENSION		TOTAL PHOSPHORUS PHOSPHORE TOTAL		TKN/ATK	
	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)	INFLUENT ENTREE (mg/ℓ)	EFFLUENT SORTIE (mg/ℓ)
1979		48	215	134	11.8	3.9	50.0	18.5
1980								
1981		36		67		3.0		12.5
1982	160	35	114	22	4.7	4.0	33.0	16.0
*	160	35	114	51	4.7	3.3	33.0	15.0

(Table 3.15)

* Valeurs medianes obtenues les 3 dernieres années.
Median values obtained over the past 3 years.

CHAPTER FOUR

WATER MANAGEMENT CONSIDERATIONS

4.1 Introduction

Historically, the Province of New Brunswick has experienced virtually a complete absence of controls on the withdrawal and use of water, from either surface or underground sources. This fact reflects the province's comparative wealth of water resources. However, in recent years demand for water has increased to the point where this situation is changing.

In fact, the water cannot be said to be managed unless there is a degree of control over the way it is used. In this regard, reference can be made to the Water Use Control Strategy for the Province of New Brunswick, prepared by Montreal Engineering Company Limited, 1976.

Generally, the major concern of a water user is to obtain water of suitable quality and in sufficient quantity to satisfy his needs at the lowest possible cost. For the individual water user, remote from a stream or lake, a well usually is the only supply available which meets these criteria.

In developing considerations for use and management of water in the region, neither groundwater nor surface water sources can be studied independently. For every proposed new water need, it is essential that the cost, advantages and disadvantages of both alternative sources be considered. There are, as well, certain situations where joint use of both resources may be required.

The first problem in many areas is to determine the extent of the available resource. That is, one must first find out if enough surface water or groundwater is available for a proposed use. Only then can a comparison of the relative quality and the cost of using the resource be evaluated.

Another important factor that should be considered in relation to a water supply is the security of the source. Any major user of water, especially a municipality, will want to select a supply source which is secure from loss or failure; or which can be made secure. The security of the source must include both quality and quantity aspects.

The relationship between water quality and water quantity should be acknowledged at this point. The ultimate use of water is determined by a combination of both factors, and it is superficial to treat one subject in isolation of the other. The downstream user will be limited by both the quantity and quality of the effluents upstream and by the quantity of water available for dilution.

Perhaps, the most important step in water management is the protection of the resource. Such protection may include taking measures against unsatisfactory waste disposal practices, detrimental land use practices, biocides, unsuitable water-related works and activities, and unsuitable developments. It may also include the protection of the community itself from the destructive effects of water. This type of protection includes life and property damage due to floods, and the erosive effects of water on the land.

4.2 Protection of the Water Resource

In the Newcastle-Chatham Planning Region, the majority of the municipalities and industrial developments are situated along the main stem of the Miramichi River. Considerable impact on the quality of the water has been observed in the past as a result of the discharged domestic and industrial wastes. However, the implementation and the continuous improvement of waste treatment facilities has resulted in better quality waters. Further improvement of the quality of the Miramichi River Basin in this region is anticipated in the future.

Today, water consumption for domestic purposes averages about 400 litres per day per person. Growth of some urban areas has required hundreds of private wells in limited areas. When surface water is used, large watershed areas are required to meet urban, domestic and industrial demands. As larger quantities of water are used, larger amounts of liquid wastes are generated. Dumping inappropriate amounts of waste into the nearest stream is no longer acceptable because it will ruin the supply for the next downstream user. Waste does not enter just water, but an aquatic ecosystem. Each ecosystem has a certain capacity to receive and assimilate these wastes. This capacity is determined by the physical, chemical and biological interactions within the ecosystem as well as the type of the waste discharged. Through an understanding of the characteristics of an aquatic ecosystem, water resource managers may develop the necessary means to gain maximum beneficial water use while allowing only minimal damage to the ecosystem.

The estimation of the assimilative capacity of a stream should, therefore, include adequate examination by an ecologist.

Today's society also uses an ever-increasing variety and volume of chemicals, which are beneficial only so long as they are used carefully and for the intended use. Salt, for example, is used to melt highway ice, but if used in excessive amounts it can impact on adjacent streams and wells.

Salt storage facilities should provide adequate control of any resulting brines from both the salt and the salt-sand mix. This control in developed areas should include the complete covering of all materials so as to prevent contamination of wells. If, however, road salt must be stored near streams, every possible provision should be made to minimize leachate discharge and to ensure that it is sufficiently diluted by the stream. Road salt applications in winter should be properly timed, and quantities used kept at the minimum absolutely necessary for safe vehicle operation. This would further reduce contamination of surface water and groundwater in such areas.

In this region, all salt storage facilities are located away from the public water supplies and recharge areas. Therefore, there are no quality problems associated with salt storage in the Newcastle-Chatham Planning Region.

In 1972, a significant oil spill occurred two miles south of the Town of Chatham at the Gulf oil bulk storage terminal. Approximately 1.05 million litres of diesel fuel spilled and was only partially recovered. There has been no evidence of fuel seepage along the natural groundwater discharge zone adjacent to the spill. It is assumed that the lost fuel is either trapped by local lithology or has migrated laterally to immobility. (Groundwater Resources Chatham, 1976). It is possible that a potential problem could develop if the existing hydraulic gradients in the area were to be reversed by overpumping.

The greatest care should be exercised in the handling of all hydrocarbon fuels, particularly near private or municipal wells. Any such pollutants present on the land surface will infiltrate rapidly to the water table. All petroleum-product tanks should be checked on a regular basis to identify leaks before they cause serious contamination of groundwater. Impermeable catchments should be constructed to trap spillage around above-surface tanks.

The province is responsible for the protection of the quality of both surface water and groundwater. Regulations under the Clean Environment Act form the basis for the water resources protection in the province. These expressly forbid contamination and permit penalties to be levied where a polluter is convicted.

There are three regulations under the Clean Environment Act which are directly involved with the protection of the water resources. These are the Water Quality Regulation, the Water Well Regulation, and the Watercourse Alteration Regulation.

The Water Quality Regulation prohibits the contamination of any water of the province and the construction of any water supply or distribution system without approval. This regulation also makes provision for the protection of any public water supply, whether from a surface source or from wells. Section 23 permits the definition of a protected area, where the Minister may designate certain activities as harmful, and therefore not allowed. For example, if a lake provides the water supply for a given town, boating, swimming and washing may be controlled or forbidden on that lake. Obviously, each public supply is unique and the desired type and level of protection should be decided on an individual basis.

The Water Well Regulation forbids the construction of any well so near to a source of contaminant that contamination of the well by groundwater flow or seepage may take place (Section 19). The regulation defines the sources of contaminant and specifies the allowable distance, away from these sources, at which a well may be located. Also, Section 20 of the regulation states that no source of contaminant shall be constructed any nearer to a well than the distance prescribed by the regulation unless the well is abandoned. The regulation also contains a provision that reports be filed containing construction details on all wells drilled in New Brunswick.

The Watercourse Alteration Regulation was prepared to ensure that the potential effects of a watercourse alteration are adequately considered at the design stage and it is intended to minimize short-term and long-term adverse effects to surface water quality, to aquatic habitat and to property owners. A permit is required for most types of alteration of any watercourse in the province. The New Brunswick Fisheries Act and the Canada Fisheries Act also require that approval for stream alterations be obtained. However, it is only necessary to apply once to the N.B. Department of the Environment; the review process for this application involves the federal and provincial fisheries interests as defined in the Fisheries Acts.

The Watercourse Alteration Regulation also prohibits the removal of sand, gravel or similar material from the bed of a river, lake or stream for the purpose of sale or use in a commercial product. Very few watercourses in New

Brunswick could withstand even small amounts of instream mining and still have adequate spawning area left to maintain an adequate salmonid population or retain any channel stability.

Overall, the planning region has adequate water resources but it should be remembered that these resources are required for a variety of uses. Through water management, conflicts in water use can be resolved and the valueable resource protected for the future.

4.3 Protection of the Water Supply Watersheds

Considerable effort and funds have been invested by the Federal Government, the provincial and municipal governments in the development of water supplies. It has not been fully appreciated that these systems can easily be contaminated and ruined by carelessness, ignorance or lack of attention.

The concept of the "protected area" was mentioned in the previous section under discussion of the Water Quality Regulation. A protected area refers to a surface water drainage basin or a site of groundwater recharge where measures are taken above and beyond the normal health, environmental and subdivision controls which apply to the province as a whole. The organization and management of a protected area will demand a great deal of cooperation between the several water users whose interests may be in conflict. A variety of possible methods are available. One approach is for a municipality to extend its boundaries to include the area requiring protection. It is then relatively simple to zone the land in a way that is compatible with water supply. Another approach, if the area is not too large, is outright purchase, as is the case of the City of Edmundston with their Iroquois River - Blanchette Brook well field. This offers the greatest control of the watershed. A third approach, if the land is owned by the Crown, is to arrange for special status and administration of the water supply area as is the case of the Musquash Watersheds west of Saint John City. All of these approaches are now being used or considered in New Brunswick.

There are two levels of protection suggested in this report. The high level of protection applies to those basins which are presently being used or have the greatest potential for use as a municipal water supply.

The low level of protection applies to those basins which are presently being used for an individual water supply plus other basins where development of a watercourse as a source of water is judged feasible. Both levels of protection should involve:

1. The minimization of stream sedimentation by:

   (i) ensuring all highway ditches are properly graded and seeded.

   (ii) urging good agricultural practices such as contour ploughing and sedimentation control structures,

   (iii) encouraging the selective harvesting of mature and over-mature timber rather than clear-cutting,

   (iv) prohibiting gravel mining in or near a watercourse or its flood plain,

   (v) ensuring watercourse alterations are properly designed and constructed, and

   (vi) by establishing a buffer strip of vegetation between a watercourse and development;

2. The reduction of pollution hazards within the basin by:

   (i) maintaining adequate sewage and wastewater treatment plants for all communities and industries,

   (ii) controlling the aerial or ground application of pesticides,

   (iii) controlling the storage of pesticides, hydrocarbons, paints or any toxic chemicals or compounds, and

   (iv) by prohibiting the storage of any compound hazardous to water quality within 30 m of the bank of a watercourse or upon its flood plain.

The high level of protection should also include land use controls which should strictly control the construction of new subdivisions and industries within the drainage basin.

Land under public ownership should be preserved in a suitable state and the percentage of the drainage area under public ownership may be increased by purchase or expropriation. Water production, consumption and quality should be regularly monitored and recorded.

The enabling legislation exists at the provincial government level but the municipality must provide the impetus to get a drainage basin or site of groundwater recharge designated as a "protected area".

4.4 Protection of Public Water Supply Wells

Protection of water supply wells is somewhat similar to the protection of watersheds and recharge areas but the problems encountered are different. For example, every town using wells should devise a method to prevent any form of development within 300 m to 500 m of its well. Here "development" means any form of residential or commercial establishment or storage of any materials which could contaminate water supplies. Should this prove impossible, the presence of specific contaminants should be forbidden through zoning; gasoline or oil storage, septic tanks, salt storage, landfills, etc.

All the incorporated and unincorporated communities within the region obtain their water requirement from groundwater sources.

Continued population growth is indicated in some areas within the region and the use of individual supplies makes management and protection of the groundwater resource difficult. Probability of aquifer contamination increases with the number of wells drilled and mutual interference between wells becomes a significant consideration as density increases.

More important, however, is the very substantial lack of sound data on the actual capacity of many of these sources. This is particularly of concern in the case of groundwater sources. In the case of surface water source there is usually some reasonably sound theoretical basis for calculating the likely yield. This is rarely the case with a groundwater source and there is no adequate substitute for proper exploration and well evaluation at the time of construction.

In order to overcome some of this lack of groundwater data in the Province of New Brunswick, a groundwater monitoring network is being developed.

4.5 Flood Plain Consideration

There are several locations within the Newcastle-Chatham Planning Region where flooding occurs. These areas are often very attractive to the developer. A consequence of flood plain development is direct flood damage during flood events. It is important that development be avoided where there is significant flood risk to life or property. In areas of known flood hazard, local authorities should control the type and/or design of developments - possibly by revisions to their zoning, subdivision or drainage by-laws.

The Province of New Brunswick and the Federal Government entered into a "General Agreement Respecting Flood Damage Reduction" on March 31, 1976 with the objective of reducing potential damages on flood plains. This Agreement recognizes that the potential for flood damage can be reduced by a number of measures, including control of the uses made of areas prone to flooding.

A sub-agreement entitled "An Agreement Respecting Flood Risk Mapping" was also signed on March 31, 1976. Under the terms of this Agreement, selected flood-prone areas in the province are being mapped and flood-risk zones delineated. They will ultimately be designated as areas wherein only certain approved development may take place.

Another sub-agreement entitled "An Agreement Respecting Studies for Flood Damage Reduction" was also signed in 1976. Under the terms of this Agreement, studies may be carried out for selected areas to determine the best measures to reduce damages as a result of flooding in the future.

On August 30, 1977, Canada and New Brunswick entered into an agreement entitled "An Agreement Respecting Flood Forecasting". Under the terms of this Agreement, the parties in cooperation with each other would develop and operate a flood forecasting system for the New Brunswick portion of the Saint John River Basin.

Local authorities can participate in these efforts by documenting flood events, cooperating in flood contingency plans and creating development controls. For regional planning purposes, the total flood plain areas, easily identifiable on a geomorphological basis, can be recognized as areas generally suitable for agricultural and recreational uses but because of the flood risk, unsuitable for other development.

Flooding along the reaches of the Miramichi River Basin within the Newcastle-Chatham Planning Region can be caused by icejamming, prolonged rainfall during spring runoff or a combination of climatological factors which create storm tides or surges along the estuary of the Miramichi River. The damage sustained by settlements along the water courses and along the shores of the inner Miramichi Bay relate to the combination of the contributing factors.

Ice jamming is frequently the cause of flooding and consequent damage along the middle reaches of the N.W. and the S.W. Miramichi, particularly on those unusual occasions (1936 flood event) when ice breakup has occurred simultaneously on both branches of the Miramichi River. Ice jamming has occurred at the MorrisseyBridge area. Middle Island below Chatham; Cassiles on the N.W.; Renous on the S.W.; below Doaktown at Porter Cove and at Bryenton on the S.W. Miramichi.

Deviations in the vertical tide fluctuations at the mouth of the Miramichi estuary may be influenced by the patterns and magnitude of weather conditions. Storm tracks of extra-tropical storms usually follow a southwest to northeast orientation in the northeastern basin. However, a time of changing atmospheric pressure have caused raised water levels along the estuary by holding in the first tide which is then overlapped by a second tide. On such occasions, damage caused by these storm surges, a term used to describe storm tides, occurs particularly in the outlying areas such as Oak Point and Escuminac. Historically, climatological conditions which have combined to create great storm surges or storm tides in the Miramichi estuary have been recorded in the months of May, June, September, October and November during the years of 1974, 1968, 1967, 1959, 1940 and 1897.

Other than those floods occurring as a result of ice jamming or storm surges the majority of floods in the Miramichi River Basin have been a result of intense rainfall occurring at the time of spring freshet. A list of historical flood events and the contributing factors can be found in Table 4.1. Areas of documented flood damage in the region are described briefly below:

MIRAMICHI ESTUARY

High tides created during storm surges in the Miramichi estuary cause flood damage on both sides of the Miramichi River from Nelson-Miramichi to Loggieville and along the north and south shorelines of Miramichi-Inner Bay.

TABLE (4.1) HISTORICAL FLOOD EVENTS IN NEWCASTLE-CHATHAM PLANNING REGION

Contributing Cause FLOOD EVENT	HEAVY OR PROLONGED PRECIPITATION	MILD TEMPERATURE	SPRING FRESHET	UNUSUALLY LATE BREAKUP	UNUSUALLY EARLY BREAKUP	ICE JAM	NORTHEASTERLY WIND	HIGHTIDES	DRAINAGE	DAMAGE
July 29, 1982	X								X	Minimal
February 2, 1976		X	X							Minor Flood Conditions
November 27, 1974	X							X		Erosion Waterfront Area Newcastle & Chatham
December 10, 1974	X									Backup flooding
April 27, 28 1973	X		X							Backup flooding
February 3,4 1970	X	X			X	X				Bridges washed away, buildings destroyed, water supply contaminated in Newcastle
October 21, 1968	X	X						X		Hurricane Gladys, River 6'feet above normal at Newcastle
May 26,27, 1967	X						X	X		"One of worst May storms in recent memory" Damage to Newcastle Waterfront area
May 27-29, 1961			X	X						Damage in upper reaches
June 26, 1959	X	X						X		"Escuminac Disaster"
March 24-31, 1953	X		X			X				Train travel disrupted.Losses by mills in Newcastle and outlying areas
April 20-22, 1950	X		X	X						Loss of boats & lumber along shore, particularly Newcastle
September 16,17, 1940							X	X		waterfront damage, "One of severest storms in memory"
November 20, 1937							X	X		"Highest tide in 25 years"
March 21-23, 1936			X		X	X				
March 13-18, 1934	X					X				"Worse freshet in 30 years"
May 1-2, 1923	X	X	X							"Swiftest freshet ever known"
April 16-19, 1915	X	X				X				No Damage

TABLE (cont)

FLOOD EVENT	HEAVY OR PROLONGED PRECIPITATION	MILD TEMPERATURE	SPRING FRESHET	UNUSUALLY LATE BREAKUP	UNUSUALLY EARLY BREAKUP	ICE JAM	NORTHEASTERLY WIND	HIGHTIDES	DRAINAGE	DAMAGE
July 8,9, 1915	X									Two bridges washed away, logs carried downstream
November 3,4, 1897	X						X	X		Flooding in downtown Newcaslte Highest tide in 19 years
September, 1884								X		Newcastle Flooded

Source of Information Used: Nicholson, 1982

NEWCASTLE: It is the wharf and Strawberry Marsh area of the waterfront of Newcastle which are most frequently flooded. Water covers the wharf area of Newcastle and high river levels at times of ice jamming or tide surges sometimes threatening bulk oil storage tanks and wharf facilities thus posing a possible pollution threat to the Miramichi River. Lumber has also been washed away. Storm surges have caused tides 3m above normal in 1940, 1.8 m above normal in 1968 and 2 metres above predicted levels in 1974.

Poor storm sewer drainage and back water flooding in downtown Newcastle seems to be the cause of some basement flooding in that area of the town. Sections of Mitchell and Castle Streets in downtown Newcastle are cited as having flood damage when water levels have had a reported depth of as much as 0.9m. Basement flooding caused damages to stored goods in commercial premises and closed downtown businesses. The dump road in Newcastle has been underwater. In 1970, Newcastle's water supply was contaminated because of improperly sealed wells.

Since 1970, few new structures have been built in the Newcastle area floodplain. Little land is available and development is occurring on the hill. The low lying area of Chatham Head is mostly vacant land with only a few private residences. It is not anticipated that there will be any prospect of development in this area (Nicholson, 1982).

NELSON-MIRMICHI: Nelson-Miramichi has never experienced serious flood damage (Nicholson, 1982). However, in 1971 surge tides and a December thaw caused some erosion along the shores of the waterfront area of Nelson-Miramichi. This village is little affected by flooding but 70 mm of rainfall at a time when ice jammed at Morrissey Bridge (Newcastle) caused some Main St. residences to severe damage because of basement flooding. Extra severe tropical storms, such as what occurred in May 1961 and November 1974, can threaten river front buildings. This was the case in the community of Chelmsford, one mile west of the village of Nelson Miramichi.

CHATHAM TO LOGGIVEILLE: Flooding in the vicinity of the town of Chatham is not frequent and reported damage has not been extensive. The waterfront has been covered almost as far as Water Street (1940) and the railway tracks (CNR line) has been disrupted along the

Chatham waterfront (1940). Wellingston Street area in Chatham has had flood waters to a level of one metre (1953). As a result of inadequate storm drainage, residences on McIntosh Street, Riverside Drive and Duke Street have had flooded basements (1974).

Ice jams occurred at the causeway leading to Middle Island. In 1974, one half of the causeway was washed away. The Shore Road to Loggieville below Chatham was flooded almost in its entirety in 1940. (Nicholson, 1982).

MIRAMICHI BAY: The years 1959 and 1940 were disaster years for several settlements along the shores of the Miramichi Bay. The"Escuminac Disaster" resulted in the loss of one third of the drift fleet in the Miramichi area. Boats were lost or damaged and damaged wharves again in 1940. Burnt Church, Oak Point and Escuminac are the communities where damage has been reported. There is no indication in documented reports of damage to low land areas along the shoreline.

The low area of Neguac on the north shore of the Bay, in the vicinity of Fair Isle Road, is particularly prone to high water levels in the spring. This combined with the fact that the area has a very high water table prevents the satisfactory percolation of effluent from the private septic tanks and is causing pollution of some wells. Open ditches into which overworked septic tank systems outlet are used for storm drainage. At times of intense precipitation or spring freshet conditions, culverts and drains are unable to handle surface runoff. This presents the community with a potential health hazard and should provide the impetus needed to secure a municipal water supply.

The New Brunswick Department of the Environment, together with the Federal Government are considering the feasibility of conducting a hydrotechnical study and flood risk mapping of the flood risk zones of the estuarine Miramichi River. Such a study would be conducted in the year 1984 under "General Agreement Respecting Flood Damage Reduction" and a sub-agreement between the two levels of government entitled "An Agreement Respecting Flood Risk Mapping".

4.6 Monitoring the Water Resource

An important role of the protection and management effort is monitoring the fluctuations in water conditions so that predictions can be made. In the field of hydrology, an assessment of water availability or the possibilities of flooding can be made by the collection of climatological, streamflow and groundwater data. However, data collection is usually an expensive operation and care must be taken to obtain the data most useful to those managing or interested in the water resource.

4.6.1 The Climatological Network

Climatological data is presently collected at several selected sites by Atmospheric Environment Services, Environment Canada, (A.E.S.) observers. These climatological sites are part of the national climatological network. In most cases, the federal program is carried out in conjunction with a cooperative agency. Presently, there are 2 active A.E.S. Climatological Stations within the region.

There are also climatological records available for several stations near enough to be useful for climate studies of the planning region. Reference can be made to the Climatological Station Data Catalog Atlantic Provinces. A list of the climatological stations in the Planning Region is presented in Appendix, Table (D.3).

A network of seasonal Climatological Stations has been established in the province by the New Brunswick Department of Natural Resources. Four of these stations are located within the Newcastle-Chatham Planning Region at Blackville, McGraw Brook, Newcastle and Rogersville. The data from these stations are utilized in determining the fire weather index for the planning region. The data is archived on microfilm but is not available at the present time in a published form. The Forest Branch of the Department of Natural 'Resources is currently accumulating and collating data for publication.

The density guideline for ordinary climatological stations is a minimum separation between stations of 40 km. An ordinary climatological station is one in which observations are made at least once daily; these include daily readings of extreme temperature and/or amounts of precipitation. (In Canada, twice-daily readings are strongly recommended as once-daily readings bias the observations.)

There is one principal station, Chatham A, in the Newcastle-Chatham Planning Region. This station is located at Canadian Forces Base Chatham. A principal station is one at which hourly readings of climatological parameters are made.

The density guideline for a precipitation station is a minimum separation between stations of 25 km. Precipitation stations are those at which observations of the amount of rainfall and snowfall only are made. There are five active stations of this class within the region; these are Acadieville, Chatham A, McGraw Brook, Mount Carleton and Upsalquitch Lake. Blackville, McGraw Brook Newcastle and Rogersville are seasonal stations.

Climatological data are forwarded to the A.E.S. Atlantic regional headquarters for checking and processing. The data are then forwarded to the national headquarters (Toronto) for final quality control, processing, publication and archiving. Climatological data are published in Monthly Record of Meteorological Observations in Canada (to 1977) and Monthly Record - Meteorological Observations in Eastern Canada (1977 on) and several other publications of the Atmospheric Environment Service of Environment Canada. Normals of precipitation and temperatures are published in two separate A.E.S. publications. These data are of use to those making decisions with respect to forestry, agriculture, water resources, highway and building design, power generation, and for the generalized statistical evaluation of the influence of climate. Hydrologists utilize the data for determining design storms used in estimation of the maximum probable flood.

4.6.2 The Hydrometric Network

As defined here, the hydrometric network presently consists of those stream-gauging stations where the amount of sediment, the water level (stage) and/or the volumetric rate of flowing water (discharge) are measured and those observation wells where the nonpumping water level is observed.

These records are mainly used by:

1. hydrologists in estimation of extreme flow events (floods and drought);

2. engineers in hydraulic design of bridges, culverts, dams and water control structures;

3. agriculturalists in estimating water availability for irrigation;

4. resource managers and government agencies responsible for resource development and management decisions; and

5. many others who utilize or are directly affected by the water resource.

Streamflow data are collected at selected hydrometric sites by the Water Survey of Canada under agreement with the Province of New Brunswick.

At the present, there are 8 active hydrometric stations in the Newcastle-Chatham Planning Region. The lengths of record at these stations vary from 1 to 35 years and their drainage areas range from 13 to 5050 sq. km.

There are also streamflow records available at seven inactive stations within the region and at a few other stations outside the planning region but near enough to be useful in water resource studies in the region: A tabulated list of active stations is also presented in Appendix D. Table (D.1). Streamflow data for all hydrometric stations, with the exception of water level stations, can be obtained from publications of the Water Survey of Canada. The discontinued hydrometric stations in the region are listed in Table (D.2).

It is too expensive to gauge every watercourse but estimations can be made based upon the hydrometric records of similar nearby watercourses. The design of a stream-gauging network should therefore include a significant number of basins in the planning region.

Groundwater monitoring is used primarily by provincial water resource managers and consultants acting on behalf of municipal and industrial clients. As mentioned earlier, a hydrometric groundwater network is under consideration by the New Brunswick Department of the Environment for the entire province.

Presently, there are four provincially and one federally operated groundwater monitoring locations in this planning region; these are located in Chatham at Gordon Street, at the Industrial Park (Walsh Avenue) and at Ellis Street, and in Newcastle in the Industrial Park. The federal station is located on the Canadian Forces Air Base in Chatham.

The hydrometric network is under continual review by the water management agencies of the Federal and Provincial governments. A review of the hydrometric network was released in 1979 (Environment Canada and the New Brunswick Department of the Environment, 1979). These agencies would welcome the suggestions of engineers, hydrologists and other interested in the adequacy of the hydrometric network.

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APPENDIX A

GENERAL INFORMATION

Table A-1

FLOW EQUIVALENTS

UNIT	CUBIC METER PER SECOND	LITER PER SECOND	CUBIC METER PER DAY	CUBIC METER PER YEAR	CUBIC FOOT PER SECOND	CUBIC FOOT PER DAY	IMPERIAL GALLONS PER MINUTE	IMPERIAL GALLONS PER DAY	MILLION IMPERIAL GALLONS PER DAY	ACRE-FEET PER DAY	ACRE-FEET PER YEAR	U. S. GALLONS PER MINUTE	U. S. GALLONS PER DAY
1 m^3/s	1	999.97	86.400E 3	31.558E 6	35.315	3.0521E 6	13.198E 3	19.005E 6	19.005	70.046	25.584E 3	15.850E 3	22.824E 6
1 l/s	1.0000E-3	1	86.402	31.558E 3	35.315E-3	3.0512E 3	13.198	19.006E 3	19.006E-3	70.048E-3	25.585	15.851	22.825E 3
1 m^3/day	11.574E-6	11.574E-3	1	365.25	408.73E-6	35.315	152.76E-3	219.97	219.97E-6	810.71E-6	296.11E-3	183.45E-3	264.17
1 m^3/year	31.688E-9	31.687E-6	2.7378E-3	1	1.1191E-6	96.686E-3	418.22E-6	602.24E-3	602.24E-9	2.2196E-6	810.71E-6	502.27E-6	723.26E-3
1 cfs	28.317E-3	28.316	2.4466E 3	893.61E 3	1	86.400E 3	373.73	538.17E 3	538.17E-3	1.9835	724.46	448.83	646.32E 3
1 ft^3/day	327.74E-9	327.73E-6	28.317E-3	10.343	11.574E-6	1	4.3256E-3	6.2288	6.2288E-6	22.957E-6	8.3850E-3	5.1948E-3	7.4805
1 Igpm	75.768E-6	75.766E-3	6.5464	2.3911E 3	2.6757E-3	231.18	1	1.4400E 3	1.4400E-3	5.3072E-3	1.9385	1.2010	1.7294E 3
1 Igpd	52.617E-9	52.615E-6	4.5461E-3	1.6605	1.8582E-6	160.54E-3	694.44E-6	1	1E-6	3.6856E-6	1.3462E-3	833.99E-6	1.2010
1 MIGD	52.617E-3	52.615	4.5461E 3	1.6605E 6	1.8582	160.54E 3	694.44	1E 6	1	3.6856	1.3462E 3	833.99	1.2010E 6
1 ac-ft/day	14.276E-3	14.276	1.2335E 3	450.53E 3	504.17E-3	43.560E 3	188.42	271.33E 3	271.33E-3	1	365.25	226.29	325.85E 3
1 ac-ft/yr	39.087E-6	38.036E-3	3.3771	1.2335E 3	1.3803E-3	119.26	515.87E-3	742.86	742.86E-6	2.7378E-3	1	619.54E-3	892.13
1 USgpm	63.090E-6	63.088E-3	5.4510	1.9910E 3	2.2280E-3	192.50	832.68E-3	1.991E 3	1.1191E-3	4.4192E-3	1.6161	1	1.4400E 3
1 USgpd	43.813E-9	43.811E-6	3.7854E-3	1.3826	1.5472E-6	133.68E-3	578.25E-6	832.67E-3	832.67E-9	3.0689E-6	1.1209E-3	694.44E-6	1

Table A-2

ABBREVIATIONS AND CONVERSIONS

MIG	=	million Imperial gallon	1 MIG	=	4546.09m^3
MIGD	=	million Imperial gallon per day	1 MIGD	=	0.0526 m^3/s = 1.858 cfs
cfs	=	cubic foot per second	1 cfs	=	0.0283 m^3/s
csm	=	cfs per square mile	1 csm	=	10.933 litre/s.km^2
Igpcd	=	Imperial gallon per capita per day	1 Igpcd	=	4.546 litre/cap. d
Igpm	=	Imperial gallon per minute	1 Igpm	=	0.0758 litre/s
ppm	=	parts per million	1 ppm	=	1 mg/dm^3 = 1 mg/litre
Igpad	=	Imp. gallon per acre per day	1 Igpad	=	1.1234 m^3/day km^2
USgpm	=	U. S. gallon per minute	1 USgpm	=	0.0631 litre/s
mile	=	statute mile	1 mile	=	1609.344 m
sq. mi.	=	square mile	1 sq. mi.	=	2.59 km^2
in.	=	inch	1 in.	=	25.4 mm
ft.	=	foot	1 ft.	=	0.3048 m
ac.	=	acre	1 ac.	=	4046.9 m^2
mm--km^2	=	millimeter on square kilometer	1 mm–km^2	=	1000 m^3
in–sq. mi.	=	inch on square mile	1 in.–s.m	=	65785.7 m^3
ac–ft	=	feet on acre	1 ac–ft	=	1233.5 m^3
1 mm--km^2/year	=	2.74 m^3/day = 0.114 m^3/hour = 0.0317 litre/sec			
	=	602.2 Igpd = 0.4182 Igpm = 0.0152 in–sm/year			
Igpm/ft	=	Imperial gallon per minute per foot (specific capacity – transmissivity – transmissibility)	1 Igpm/ft	=	0.2486 x 10^{-3} m^2/s
Igpd/sq. ft.	–	Imperial gallon per day per square foot of cross–section	1 Igpd/sq.ft.	=	0.5663 x 10^{-6} m/s
		(Specific discharge – conductivity – permeability)		=	0.04893 m/day

TABLE (A.3)

ABBREVIATIONS USED IN TEXT

cm = centimetre
cu. m = cubic metre
Kg = Kilogram
Km = Kilometre
l/day = litres per day
l/s = litres per second
m = metre
mm = millimetre
m^2/day = square metres per day
m^3/s = cubic metres per second
mg/l = Milligram per litre
Mw = Megawatt
NTU = Nephelometric turbidity units
sq. Km = square Kilometre
°c = Degrees centrigrade

APPENDIX B

GLOSSARY

- A -

area, catchment - see drainage area

area, drainage - see drainage area

aquiclude - a formation which, although porous and capable of absorbing water slowly, will not transmit it fast enough to furnish an appreciable supply for a well or spring, ref (10)

aquifer - a formation, group of formations, or part of a formation that is water bearing, ref (10)

axial length - the distance from the outlet of a drainage basin to the most remote point of that basin, ref (9)

- B -

bank protection - in a narrow sense, revetment or other armor stabilizing a bank against erosion; more generally, any means to accomplish the purpose, including devices deflecting the erosion forces away from the bank, ref (6)

bar - (1) a site in a channel of a watercourse where sand and gravel deposits have accumulated; (2) the deposits themselves, ref (9)

basement complex - a series of complex igneous and metamorphic rocks, overlain unconformably by sedimentary strata, ref (10)

basin area - area within the watershed; drainage basin; also the area of such a basin, ref (3)

basin perimeter - the perimeter of the area within the watershed, ref(9)

basin length - the distance from the outlet to the most remote point of the basin.

- C -

Cambrian - see geologic time scale

compactness coefficient - an indication of basin shape obtained by dividing the perimeter of the basin by the circumference of a circle of equal area to that of the basin; high values of a compactness coefficient indicate basins which are long and narrow, ref (9)

- D -

Devonian - see geologic time scale

discharge - the quantity of water, silt or other mobile substances passing along a conduit per unit of time; rate of flow, cubic feet per second, litres per second, millions of gallons per day, etc., ref (9)

divide - the ridges or regions of high ground that separate the drainage basins of streams, ref (11)

drainage area - (1) the area (square metres, acres, etc.) of a drainage basin; (2) catchment area, drainage basin, ref (3); (3) the area that is drained by a watercourse, ref (1), (9)

drainage pattern - the system of watercourses which provides drainage of an area, ref (9)

- E -

ecology - the (branch of biology) science dealing with the relation between living organisms and their environment; the relationship between and distribution of human groups relative to resources with consequential social and cultural patterns, ref (7)

environment - all of the surrounding conditions and influences that affect the development of a living thing, ref (7)

erosion - wearing away of land by physical and chemical action in moving water or air, ref (6)

erosion control work - construction to lessen erosion of the banks of the watercourse, ref (9)

estuary - tidal reach at the mouth of a river, ref (5)

extrusive rocks - igneous rocks formed when magma flows over the earth's surface, ref (11)

- F -

fecal coliforms - bacteria present in animal and human wastes; their presence indicating contamination of a water supply, ref (10)

fault - a fracture in a rock surface, along which there is displacement of broken surfaces, ref (11)

flood - (1) a relatively high flow as measured by either gauge height or discharge quantity. Also any flow equal to or greater than a designated basic flow; (2) to inundate or overflow, ref (8)

flood, annual - (1) the highest discharge in a water year; (2) the flood which was equalled or exceeded once each year on the average, ref (8) flood, computed maximum - the largest momentary flood discharge believed possible from a consideration of meteorologic conditions and snow cover within the watershed, ref (8)

flood damages - the costs associated with flooding, including indirect and intangible costs except where noted, ref (9)

flood damage reduction - see flood protection

flood plain - flat land bordering a watercourse and subject to flooding, ref (5)

flood protection - measures taken to protect lines, or property from risk of flood, ref (9)

fluvial - of or produced by the water flow of a watercourse, ref (9)

flow duration curve - graph of flow vs. the percentage of flows greater or less, ref (9)

form factor - an indication of the basin shape obtained by dividing the area of the basin by the square of the basin length.

- G -

gallery - a horizontal type of water installation used where the aquifer is thin or of low permeability, ref (10)

geologic time scale - a system for the recording of natural events over incredibility long periods of time; the longest division of time in the geologic timetable is the era which is subdivided into periods which are further divided into epochs, ref (11)

The eras are:
Cenozoic - Age of Mammals
Mesozoic - Age of Reptiles
Paleozoic - Age of Invertebrates, Fishes and Amphibians
Proterozoic)
Archeozoic) Precambrian
Azoic)

The Neogene is also called the Quaternary period and the Paleogene is also called the Tertiary period.

FIGURE B-1

GEOLOGIC TIME SCALE

Era	Period	Epoch	Duration In Millions Of Years	Millions Of Years Ago Started
Cenozoic	Neogene (Quaternary)	Recent	0.15	-
		Pleistocene	1.9	2
	Paleogene (Tertiary)	Pliocene Miocene Oligocene Eocene Paleocene	68	70
Mesozioc	Cretaceous		65	135
	Jurassic		45	180
	Triassic		45	225
Palezoic	Permian		45	270
	Pennsylvanian	Carboniferous	60	330
	Mississippian		20	350
	Devonian		50	400
	Silurian		40	440
	Ordovician		60	500
	Cambrian		100	600
Precambrian				

SOURCE: Simplified form, ref (11)

glaciofluvial deposits - those unconsolidated deposits emplaced by stream action originating from the melting of glaciers, ref (10)

glaciomarine - having to do with glacial deposits in a sea water environment, ref (10)

- H -

head pond - an impoundment of water of any size, behind a man-made dam, which has as its primarily function the providing of head for a prime mover, such as a turbine, ref (9)

high water - a water level which is higher than normal in lakes, rivers, and streams, ref (9)

hydraulic - pertaining to water in motion and the mechanics of that motion, ref (6)

hydraulic elements - the depth, area, perimeter, mean depth, hydraulic radius, velocity, energy and other quantities pertaining to a particular stage of flowing water, ref (1)

hydrograph - a graph of water discharge or water surface elevation on the ordinate versus time on the abscissa, ref (9)

hydrologic - pertaining to the cyclic phenomena of waters of the earth -- successively as precipitation, and quantities pertaining to a particular stage of flowing water, ref (1)

hydrometric station - a station for the direct or indirect measurement of stage or discharge; for criteria for establishing a hydrometric station are accessibility, adequacy, stability and permanency, ref (12)

- I -

ice marginal features - geological features created at the margins of a glacier, ref (10)

impervious - a term applied to a material through which water cannot pass or through which water passes with great difficulty; impermeable, ref (8)

indurated - rendered hard, ref (10)

interference - the lowering of a water level in a well as a result of pumping in a nearby well, ref (10)

intrusives, intrusive rocks - rocks formed when magma solidifies among other rocks below the earth's surface, ref (11)

inundation - an overflowing; flood, ref (1)

irrigation - the artificial application of water to lands for agricultural purposes, ref (3)

- J -

jam - accumulation of debris, ice or other material so as to become wedged in the channel of a watercourse, and forming a partial or complete obstruction, ref (9)

Jurassic - see geologic timetable

- L -

lava - liquid rock material that flows out on the surface of the earth from sources below, ref (11)

- M -

marsh - low land covered at times by water, ref (1)

marine - having to do with the sea, ref (10)

mass curve - a graph of the cumulative values of a hydrologic quantity, generally as ordinate, plotted against time or date as abscissa, ref (12)

metasediments - partly metamorphosed sedimentary rocks, ref (10)

Mississippian - see geologic timetable

- N -

navigable water - there is no definition of navigable water given in the Navigable Waters Protection Act, R. S. C. 1970 Chapter N-19. If requested the Federal Ministry of Transport will give its views as to whether a particular body of water is navigable. The Ministry of Transport takes no responsibility for having advised that in its opinion a water is not navigable is a court later holds that it is, or vice versa, ref M. O. T. publication

navigation - the movement of people or goods by water, ref (9)

- O -

Ordovician - see geologic time scale

- P -

Paleozoic - see geologic time scale

peneplane - the flat surface that remains after the wearing down of landforms by the agents of weathering and erosion, ref (1)

Pennsylvanian - see geologic time scale

Permian - see geologic time scale

physiography - the branch of geology that deals with the earth's surface resources, ref (11)

Precambrian - see geologic time scale

- Q -

Quaternary - see geologic time scale

- R -

recharge - downward infiltration of rainfall and snowmelt to the water table, ref (11)

recurrence interval - average period of years between observed or predicted occurences of a discharge or stage equalling or exceeding a stated value, ref (5)

- S -

safe yield - the rate at which water can be withdrawn from an aquifer without depleting the supply to such an extent that withdrawal at this rate is harmful to the aquifer, or to the quality of the water, or is no longer economically feasible, ref (10) salmonoid - of or related to the salmon family, which includes salmon and trout, ref (9)

salt water intrusion - moving inland of sea water as a result of too high a pumping rate of wells in coastal areas, ref (10)

Silurian - see geologic time scale

strata - rock layers or beds, ref (11)

surficial geology - the geology of unconsolidated materials at the land surface, ref (10)

syncline - the trough or downfold of a rock fold, ref (11)

synclinal - in the form of synclines, i.e. folded such that the beds dip inward from both sides toward the axis, ref (10)

- T -

till - non-sorted, nonstratified sediment carried or deposited by a glacier, ref (10)

topography - the physical features of a region, ref (11)

Triassic - see geologic time scale

- U -

unconsolidated deposits - loose geologic materials such as clay, sand, and gravel resting on top of bedrock, ref (10)

- W -

watercourse - the full width and length, including the beds, banks, sides and shoreline of any river, creek, stream, spring, brook, lake, pond, reservoir, canal, ditch or other natural or artificial channel open to the atmosphere, or any part thereof, the primary function of which is conveyance or containment of water whether the flow be continuous or not; ref N. B. Clean Environment Act

watercourse alteration - any change made intentionally, at, near or to a watercourse or to water flow in a watercourse, both temporary and permanent and includes:
(i) any changes made to existing structures in the watercourse including repairs, modifications or removal, whether the water flow is altered or not;
(ii) the temporary or continuous operation of machinery on the bed of a watercourse other than at a recognized fording place;
(iii) any removal of sand, gravel, rock, topsoil or similar material from a watercourse or within thirty metres of the bank of a watercourse;
(iv) any removal of vegetation from the bed or bank of a watercourse; and
(v) any removal of trees within ten metres of the bank of a watercourse; ref N. B. Clean Environment Act

watershed - (1) a series of slopes that drain into a river system, ref (11); (2) the topographical divide which defines a drainage basin, ref (9)

water supply design curves - graphs on logarithmic paper of streamflow versus a period of time useful in the design of water supply systems, ref (9)

water table - the upper boundary of the groundwater, below which all spaces within the rock are completely filled with water, ref (11)

water quality standards - objectives and criteria regarding the acceptability of certain physical, chemical and biological parameters of water, as related to a particular use, ref (9)

wave cut terrace - a terrace cut as a result of wave action along a former shoreline, which has since been lifted up, ref (11)

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APPENDIX C

INDUSTRIAL AND MUNICIPAL WASTES IN THE NEWCASTLE-CHATHAM REGION

C.1 Major Industries in the Newcastle-Chatham Planning Region

The major industries in the capital intensive economy of the Newcastle-Chatham Planning Region are mainly resource based. Most are forest oriented industries, such as lumbering and wood processing. Mineral exploration and mining have played a significant role in the area since the Heath Steele Mines Ltd. situated 50 km northwest of Newcastle. It remains the only working operation at time of writing and its closure is being forecasted. Chatham and Newcastle are bulk oil storage depots for two major oil companies. Agriculture plays a lesser role in the economy of the region as a whole but may become a significant resource base for such communities as Rogersville.

Fisheries and fish processors were a traditional community employer over the years but only a few fisheries survive along the east coast of Northumberland. Service support for the sport fishing is a significant contribution to the economy of the Miramichi but declining salmon stock is eroding this base as well.

Table (C.1) presents a list of major industries in the Newcastle-Chatham Planning Region and identifies contaminates which may contribute to the loss of water quality in the receiving watercourse.

Boise Cascade Canada Ltd. - Boise Cascade currently operates a 550 ton per day pulpmill at Newcastle which produces market bleached, semi-bleached and unbleached pulp. In 1969, the company started construction on its effluent treatment facilities which include two primary clarifiers for removal of solids and two biological lagoons for treatment of the mill organic loading. Since that time, the company has continued to make improvements to both the effluent treatment facilities and the mill process.

Acadia Forest Products Ltd. - Acadia produces approximately 390 tons per day of market groundwood pulp. In 1975, the company installed a primary clarifier and sludge handling equipment for removal of suspended solids from the mill effluent. The mill does not have treatment facilities for BOD removal. The current level of BOD discharge from the mill primary clarifier is approximately 12,000 pounds per day.

Northwood Pulp and Timber Ltd. - This plant produces hardwood waferboard for use in building materials and furniture manufacturing. Hot water is used to condition the incoming logs prior to being waferized. The water is collected, filtered and returned back to the log conditioning process. There is no effluent discharge.

Table (C.1) Major Industries in the Newcastle-Chatham Planning Region

Industry	Location	Treatment	Receiving Stream	Contamination
Heath Steele Mines Ltd.[1]	50 km NW of Newcastle	Neutralization & Clarification	South Tomogonops	Heavy metals
Co-Op Baie St. Anne[2]	Escuminac (at wharf)	Screening	Gulf of St. Lawrence	SS, BOD
Albert & Son Fisheries[3]	Neguac (at wharf)	Screening	Gulf of St. Lawrence	SS, BOD
Neguac Shellfish Ltd.[4]	Lower Neguac	Screening	Gulf of St. Lawrence	SS, BOD
Shippley's Fisheries[5]	Eel River Bridge	Settling	Gulf of St. Lawrence	SS, BOD
Boise Cascade Canada Ltd.[6]	Newcastle	Miramichi River	Sedimentation & Aeration	BODT, SS, Bark
Acadia Forest Products[7]	Nelson-Miramichi	Miramichi River	Clarifier	BODT, SS, Bark Pile
Domtar[8]	Newcastle	Surface runoff some reaching the Miramichi	Evaporation	Residual Sludge
Burchill[10]	Closed			
Northwood Pulp & Timber Limited.[11]	Morrison Cove		Recycled	

Table (C.1) COMMENTS

1. The Company is treating all mine and well water as well as the contaminated run-off of the full satisfaction of the department. In the past ten years there were no incidents endangering the salmon population in the NW Miramichi River.

2 to 4 These fish plants operate effluent control facilities specified by the Fish Processing Operations Liquid Effluent guidelines. These facilities remove, however, only suspended solids. Dissolved organic matter is not removed since the effluent includes blood, occasional complaints are received.

6. At a flow rate of 13.9 MG.D. (US) the biological oxygen demand (BODT) is 4500 lb/day and the suspended solid (SS) loading is 12322 lb/day. A bark pile is located across the highway (Rte 8) from the mill.

7. An average daily flow of 1.62 MGD (US) through the mills clarifier results in a BOD loading of 12,000 lb/day and SS of 4200 lb/day. Bark is piled across the highway from the mill.

8. Some surface runoff is reaching the Miramichi River. Plant effluent is evaporated;and the residual sludge is shipped to Quebec for incineration.

10. There is no discharge due to recycling of log pond effluent in log conditioning process. The plant's disposal site is located on company property behind plant.

Domtar Chemicals Ltd. - This wood preserving plant treats railway ties and utility poles using the Pentachlors phenol, creosote and ammonia-copper-arsenic processes. The plant effluent is collected and sent to an evaporator for waste removal. The residual sludge is shipped to a waste disposal company in Quebec for incineration. In addition, the company operates oil removal facilities for treating the plant waste condensates.

There are no specific problems with water supply contamination.

The bulk storage plants in the area are presently undergoing general upgrading.

C.2 Municipal Wastes in the Newcastle-Chatham Planning Region

Due to space limitation within the present report, detailed discussion of municipal wastes in the region will not be presented. A summarized tabulated list of sewage treatment plants in the Newcastle-Chatham Planning Region is presented in Table (C.2). Further information may be obtained from the Pollution Control Branch, New Brunswick Department of the Environment, Fredericton, New Brunswick.

TABLE (C.2) SEWAGE TREATMENT PLANTS IN THE NEWCASLTE-CHATHAM PLANNING REGION

Name	Location	Type	Design Capacity 10^6 Lit/d	Receiving Stream
Millerton High School	Millerton	Rotating Biological Contractor	.0136	S.W. Miramichi River
Sunny Corner Elementary School	Sunny Corner	Lagoon (.40 hectare)	.0909	Small stream to N.W. Miramichi River
Baie Ste-Anne School	Baie Ste-Anne	Lagoon (.40 hectare)	.0909	Baie Ste-Anne
Heath Steele Mines		Precipitation & Sedimentation		
Burnt Church Indian Reserve	Burnt Church	Lagoon (.8 hectare)	.061	Burnt Church River
Neguac Junior High School	Neguac	Extended Aeration	.068	Neguac Bay
Air Base Chatham	Chatham	Activated Sludge	1.28	Smallstream to Napin
Eel Ground Indian Reserve	Eel Ground	Lagoon (.8 hectare)	.18	N.W. Miramichi River
Dungarvon Institution	Renous	Modified extended aeration	.568	Renous River
Town of Chatham	Chatham	Oxidation ditch	3.78	Miramichi River
Town of Newcastle	Newcastle	Oxidation ditch	3.78	Miramichi River

TABLE (C.2) SEWAGE TREATMENT PLANTS IN THE NEWCASTLE-CHATHAM PLANNING REGION

Name	Location	Type	Design Capacity 10^6 Lit/d	Receiving Stream
The Enclosure Park	Newcastle	Trickling Filter	.045	N.W. Miramichi River
Northwood Pulp & Paper Ltd.	Chatham	Extended Aeration	.018	Miramichi River
Kerr Mobile Home Park	Chatham	Lagoon (.3 hectare)	.063	Black Brook
Boise Cascade Canada Limited	Newcastle	Sedimentation & Aeration	81.8	Miramichi River
David Curtis Mobile Home Park	Chatham	Extended Aeration	.0075	Napan River
Mactavish Mobile Home Park	Douglastown	Trickling Filter	.045	Miramichi River
C.A. Clark Subdivision	Douglastown	Trickling Filter	.0227	Miramichi River
Acadia Forest Products Ltd.	Nelson-Miramichi	Sedimentation	8.18	Miramichi River
Village of Douglastown	Douglastown	Modified Extended Aeration	.682	Mutchison Brook
St. Margarets CFS	St. Margarets	Clarigester	1.31	Small stream to Bay Duvin River

TABLE (C. 2) SEWAGE TREATMENT PLANTS IN THE NEWCASTLE-CHATHAM PLANNING REGION

Name	Location	Type	Design Capacity 10^6 Lit/d	Receiving Stream
KOA Campground	Loggieville	Lagoon (.2 hectare)	.04	Miramichi River
Village of Blackville	Blackville	Lagoon	.636	Bartholomew River
Village of Nelson-Miramichi (including	Chatham Head)	Lagoon	1.09	Miramichi River
Village of Rogersville 1	Rogersville	Aerated Lagoon & Polishing pond	.636	East Barnaby River
Village of Rogersville 2	Rogersville	Aerated Lagoon & Polishing Pond	.218	East Barnaby River

"Source: Pollution Control Branch, N.B. Dept. of the Environment

APPENDIX D

LISTS OF HYDROMETRIC, CLIMATOLOGICAL, AND WATER QUALITY STATIONS IN THE REGION

Table D.1
ACTIVE HYDROMETRIC STATIONS IN THE CHATHAM-NEWCASTLE PLANNING REGION

Station Number	Station Name	Flow Regime	Drainage Area (sq. Km)	Length of Record (yrs.)	Extreme Daily Flow	
					Maximum (cu.m/s)	Minimum (cu.m/s)
01BK005	Forty Mile Brook at Caribou Depot	Reg.[1]	14.2	1	----	----
01BK006	Forty Mile Brook (West Branch) at Caribou Depot	Nat.[2]	13.0	1	----	----
01B0001	Southwest Miramichi River at Blackville	Nat.	5050.	35	2190	9.34
01B0002	Renous River at McGraw Brook	Nat.	611.	16	320	0.677
1B0003	Barnaby River below Semiwagan River	Nat.	484.	8	186	0.272
1BQ001	Northwest Miramichi River at Trout Brook	Nat	948	20	487	1.56B
1BQ003	Little South Branch Tomogonops River below B Pit	Reg.	---	8	6.94	0.012
1BP001	Little Southwest Miramichi River at Lyttleton	Nat.	1340	29	861	1.70B

1. Reg. - Regulated Flow
2. Nat. - Natural Flow

Table D.2

DISCONTINUED HYDROMETRIC STATIONS IN THE NEWCASTLE-CHATHAM PLANNING REGION

Station Number	Station Name	Flow Regime	Drainage Area (sq. Km)	Length of Record (yrs.)	Extreme Daily Flow	
					Maximum (cu.m/s)	Minimum (cu.m/s)
1BQ007	Tomogonops River at the mouth	Reg.	158	7	88.6	0.261
1BQ004	South Branch Tomogonops River at Tailings Pond Site no. 1	Reg.	---	6	---	---
1BQ005	South Branch Tomogonops River at Tailings Pond Site no. 2	Reg.	---	2	---	---
1BQ008	Tomogonops River at Tailings Pond site no. 3	Reg.	---	1	---	---
1BQ006	South Branch Tomogonops River near Heath Steel Mines	Reg.	---	7	4.05	0.048
1BQ002	Little South Branch Tomogonops River at Fresh Water Pond	Reg.	---	10	2.94	0
1BO004	Bartibog River below Highway no. 8	Nat.	316	3	111	1.02

Table D.3

CLIMATOLOGICAL STATIONS IN THE NEWCASTLE-CHATHAM PLANNING REGION

Station Number	Station Name	Latitude		Longitude		Elev. m	Period of Record
		°	'	°	'		
8100105	Acadieville	46	44	65	17	61	1980 (active)
8100400	Ashton Hill Tower	47	06	65	44	279	1935-1947
8100525	Big Bald Mountain	47	12	66	26	.....	1935-1946
8100540	Black Brook	46	40	65	40	224	1935-1935
8100545	Blackville *	46	40	65	40	21	1936-1941
8100600	Burnt Church	47	12	65	08	8	1934-1958
8100601	Burnt Church	47	14	65	08	15	1974-1976
8100800 -	Cedar Camp	47	24	66	08	---	1929-1932
8100990	Chatham	47	03	65	29	30	1873-1947
8101000	Chatham A	47	01	65	27	34	1943-(active)
8101020	Chatham NBEPC	47	03	65	28	4	1960-(inactive)
8102350	Little River Mine	47	17	66	04	335	1956-(active)
8102570	Martins Bluff	46	56	66	39	—	1935-1941
8102808	McGraw Brook *	46	49	66	07	53	1969-(active)
8102820	McKendrick Lake	46	40	66	22	—	1935-1942

*Seasonal Station

Source: Environment Candda, Atmospheric Environment (1980) "Climatological Station Data Catalogue - Atlantic Provinces."

TABLE D.3

Station Number	Station Name	Latitude °	'	Longitude °	'	Elev.	Period of Record
8103256	Mount Carleton	47	26	66	55	259	1973-(active)
8103450	Nelson	46	59	65	34	17	1938-1946
8103600	Newcastle *	47	00	65	34	15	1948-1952
8104465	Renous	46	48	65	48	46	1953-1978
8104465	Rogersville *	46	46	65	27	64	1974-1976
8105050	South Nelson	46	59	65	34	15	1947-1948
8105540	Upper Blackville	46	38	65	52	23	1962-1966
8105551	Upslaquitch Lake	47	27	66	25	625	1967-(active)

Seasonal Stations*
Some service is interrupted

Table D.4
PROVINCIAL WATER QUALITY STATIONS ON RIVERS AND LAKES IN THE NEWCASTLE-CHATHAM PLANNING REGION

Station Number	Name of Watercourse	Year Estab-lished	Latitude o	Latitude '	Latitude "	Longitude o	Longitude '	Longitude "
00BR01 BO 0004	Miramichi R. @Chatham	1981	47	1	48.865	65	29	0.35
00BR01 BO 0005	Miramichi R. @Newcastle	1981	46	59	54.135	65	33	41.51
00BR01 BO 0007	Miramichi R. @Quarryville	1981	46	49	40.665	65	47	12.55
00BR01 BO 0008	Renous River @Mouth	1981	46	48	56.235	65	47	40.92
00BR01 BO 0009	Dungarvon River @Pineville	1981	46	48	52.855	65	54	17.14
00BR01 BO 0010	Bartholomeu River@Mouth	1981	46	44	14.325	65	49	54.77
00BR01 BO 0011	Miramichi R. @Blackville	1981	46	44	9.745	65	49	42.74
00BR01 BP 0001	Little Southwest Miramichi	1981	46	56	4.885	65	54	35.78
00BR01 BQ 0011	Northwest Miramichi @Exmoor	1981	46	57	54.405	65	49	38.86
00BR01 BN 0001	Cains River near mouth	1981	46	39	54.425	65	46	39.94
00BR01 BN 0002	Miramichi R. @Upper Blackville	1981	46	37	10.425	65	52	47.78
01BR01 BK0001	Nepisiquit Lake	1975	47	23	16	66	48	41
01BR01 BK0002	Nepisiquit Lake	1975	47	22	57	66	48	1
01BR01 BK0003	Nepisiquit Lake	1975	47	22	31	66	48	4
01BR01 BK0004	Nepisiquit Lake	1975	47	22	35	66	46	50
00BR01 BK0004	Nepisiquit River							
00BR01 BK0005	Nepisiquit River							
00BR01 BK0009	Nepisiquit River							
00BR01 BK0010	Forty Mile Brook		47	44	56	72	51	35

Source: Environmental Services Branch, N.B. Dept. of the Environment

Table D.5
FEDERAL WATER QUALITY STATIONS ON RIVERS AND LAKES IN THE NEWCASTLE-CHATHAM PLANNING REGION

Station Number	Name of Watercourse	Period of Record	No. of Samples	Stations Latitude o	'	"	Location Longitude o	'	"
00NB01BN0001	Cains River @Mouth	Oct 70-Sept.77		46	39	54	65	46	33
00NB01B00001	Miramichi River @Blackville	July 65-Sept.77		46	44	9	65	49	36
00NB01B00002	Renous River near McGraw Brook	June 69-Sept.77		46	49	18	66	6	51
00NB01B00007	Barnaby River @Barnaby River	Nov 70-Sept.74		46	53	10	65	31	05
00NB01B00019	Bartibog River @Hwy 8	Oct 70-Sept.77		47	11	21	65	24	24
00NB01BP0001	Little Southwest @Lyttleton	July 65-Sept.77		46	56	6	65	54	30
00NB01BQ0001	Northwest Miramichi @Redbank	July 65-Sept.77		46	56	39	65	49	21
00NB01BQ0004	South Tomogonops @Hwy 340	June 62-Feb 74		47	15	36	66	2	3
00NB01BQ0008	Sevogle River @mouth	Oct 70-Sept 76		47	2	54	65	50	21
00NB01BQ0013	Little South Tomogonops (above mine)	June 65-Feb 74		47	18	30	66	4	57
00NB01BQ0077	Little South Tomogonops (below mine)	June 66-Aug 76		47	17	21	66	1	39
00NB01BQ0018	Tomogonops River - Mouth	June 63-Aug 76		47	13	57	65	50	6
00NB01BQ0079	Northwest Miramichi-Above Tomogonops	June 66-Aug 76		47	13	57	65	50	9
00NB01BQ0029	South Sevogle River (above clearwater Stream)	July 68-Oct 73	30	47	3	15	66	10	54
00NB01BQ0031	South Sevogle River (below Sheephouse Brook)	July 68-Oct 73	28	47	4	39	65	59	0
00NB01BQ0035	Northwest Miramichi River @Payne	July 70-Sept.73	25	47	26	18	65	53	54
00NB01BQ0044	Northwest Miramichi River @Wayerton	Jan 71-Sept.76	30	47	8	6	65	60	6
00NB01BQ0053	Northwest Miramichi River @Curventon	June 63-Mar 75	230	47	3	39	54	49	54
00NB01BQ0056	Northwest Miramichi River Hwy 430	Oct 74-Sept 77	10	47	11	15	65	53	36
00NB01BK0017	Nepisiquit River above Wedge Mine	May 66-Nov 71		47	23	39	66	8	15
00NB01BK0032	Nepisiquit River above 40 Mile Brook	June 68-Aug 76		47	23	33	66	7	18
00NB01BR0035	Nepisiquit River above Portage Brook	July 68-Aug 76		47	24	6	66	31	21

Source: Environment Canada, 1979, Water Quality Data New Brunswick 1961-1977

Table D.5

FEDERAL WATER QUALITY STATIONS ON RIVERS AND LAKES IN THE NEWCASTLE-CHATHAM PLANNING REGION

Station Number	Name of Watercourse	Period of Record	No. of Samples	Stations Latitude			Location Longitude		
				o	'	"	o	'	"
00NB01BN0001	Cains River @Mouth	Oct 70-Sept.77		46	39	54	65	46	33
00NB01B00001	Miramichi River @Blackville	July 65-Sept.77		46	44	9	65	49	36
00NB01B00002	Renous River near McGraw Brook	June 69-Sept.77		46	49	18	66	6	51
00NB01B00007	Barnaby River @Barnaby River	Nov 70-Sept.74		46	53	10	65	31	05
00NB01BO0019	Bartibog River @Hwy 8	Oct 70-Sept.77		47	11	21	65	24	24
00NB01BP0001	Little Southwest @Lyttleton	July 65-Sept.77		46	56	6	65	54	30
00NB01BQ0001	Northwest Miramichi @Redbank	July 65-Sept.77		46	56	39	65	49	21
00NB01BQ0004	South Tomogonops @Hwy 340	June 62-Feb 74		47	15	36	66	2	3
00NB01BQ0008	Sevogle River @mouth	Oct 70-Sept 76		47	2	54	65	50	21
00NB01BQ0013	Little South Tomogonops (above mine)	June 65-Feb 74		47	18	30	66	4	57
00NB01BQ0077	Little South Tomogonops (below mine)	June 66-Aug 76		47	17	21	66	1	39
00NB01BQ0018	Tomogonops River - Mouth	June 63-Aug 76		47	13	57	65	50	6
00NB01BQ0079	Northwest Miramichi-Above Tomogonops	June 66-Aug 76		47	13	57	65	50	9
00NB01BQ0029	South Sevogle River (above clearwater Stream)	July 68-Oct 73	30	47	3	15	66	10	54
00NB01BQ0031	South Sevogle River (below Sheephouse Brook)	July 68-Oct 73	28	47	4	39	65	59	0
00NB01BQ0035	Northwest Miramichi River @Payne	July 70-Sept.73	25	47	26	18	65	53	54
00NB01BQ0044	Northwest Miramichi River @Wayerton	Jan 71-Sept.76	30	47	8	6	65	60	6
00NB01BQ0053	Northwest Miramichi River @Curventon	June 63-Mar 75	230	47	3	39	54	49	54
00NB01BQ0056	Northwest Miramichi River Hwy 430	Oct 74-Sept 77	10	47	11	15	65	53	36
00NB01BK0017	Nepisiquit River above Wedge Mine	May 66-Nov 71		47	23	39	66	8	15
00NB01BK0032	Nepisiquit River above 40 Mile Brook	June 68-Aug 76		47	23	33	66	7	18
00NB01BR0035	Nepisiquit River above Portage Brook	July 68-Aug 76		47	24	6	66	31	21

Source: Environment Canada, 1979, Water Quality Data New Brunswick 1961 - 1977

Table D.6
Snow Course Stations in the Newcastle-Chatham Planning Region

Station Name	Latitude		Longitude		Elevation Metres	Years of Record	Agency Operating Station
	o	'	o	'			
Mount Carleton	47	26	66	55	259	9	Tourism N.B.
Serpentine Lake	47	09	66	53	381	22	NBEPC
Long Lake	47	04	66	55	381	23	NBEPC
Trout Brook	47	06	65	50	23	21	W.S.C.
Lyttleton	46	56	65	55	23	29	W.S.C.
Renous	46	49	66	07	69	17	W.S.C.
Chatham DND	47	01	65	26	34	17	DND

Source: New Brunswick Department of Environment Snow Course Site Descriptions

APPENDIX E

FLOW DURATION CURVES OF HYDROMETRIC STATIONS IN THE REGION

Introduction:

Flow duration curves have been developed for selected hydrometric stations in the Newcastle-Chatham Planning Region. Data up to 1983 were used in this development. These flow duration curves are presented in this appendix.

These flow duration curves show the percentages of time that various rates of discharge have been equalled or exceeded. Streamflow characteristics such as dependability of low flows in times of drought and persistance in times of flood may be readily obtained from these curves.

The flow duration curve is a useful device for analyzing and predicting the variability of streamflow. Such a curve defines the frequency of occurrence of various rates of flow without regard to chronological sequence. Thus, a major disadvantage of this type of analysis is that it is not possible to tell whether the lowest flows occurred in consecutive periods or were scattered throughout the record.

However, flow duration curves have been widely used by engineers to solve problems related to water supply, power developments, sediment production, dilution and disposal of sewage and industrial wastes. The shape of the flow duration curve is indicative of the groundwater contribution to the stream, geologic structure, topography, soil type, vegetation, and other factors. It provides a convenient and appropriate means of relating the characteristics of different streams.

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STATION :   01BO001    FLOW                    SOUTHWEST MIRAMICHI RIVER AT BLACKVILLE
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.      0 DAYS.

YEAR       MAX       MON DY      MIN        MON DY    TOT DAYS     MEAN        STD        MISSED
        FLOW,CMS              FLOW,CMS              DAY USED   FLOW,CMS   DEVIATION     MONTHS


1918      387.00    11  1       31.10       8 24    153 143      92.93       66.61     1  2  3  4  5  6  7
1919      736.00     4 14       21.50       8 24    365 365     109.58      118.40
1920      787.00     4 14       19.80       3  1    366 366     131.85      160.03
1921      629.00     4  3       11.30       2 11    365 365      94.77      120.30
1922      838.00     6 23       18.40       2 21    365 365     103.06      105.78
1923     1980.00     5  1        9.34       9 15    365 365     103.08      185.52
1924     1089.00     5  2       10.70      10 29    366 366      94.48      184.40
1925      555.00    11 25       14.20       2  8    365 365     131.74      109.21
1926      966.00     5 10       18.90       8  3    365 365     135.74      192.60
1927     1080.00     4 24       25.80       2 28    365 365     140.41      147.00
1928      940.00     5  4       29.40       9 10    366 366     110.72      144.93
1929      872.00     5  4       18.00       9  9    365 365     102.78      132.82
1930      671.00     5  6       24.90      12  5    365 365     113.56      123.66
1931      547.00     4 14       13.60       2  8    365 365     102.07      110.32
1932      949.00    10 29       22.70       2 24    366 366     134.14      167.64
1933     1060.00     5  3       17.00       2  7    181 181     165.52      217.93     7  8  9 10 11 12
1938      548.00    12 12       25.50      12  4     92  92     123.28      141.26     1  2  3  4  5  6  7  8  9
1939     1060.00     5 11       15.00       1 31    273 273      98.94      165.79    10 11 12
1961      487.00     6  1       26.00       8 21    214 214     100.19       73.38     1  2  3  4  5
1962      586.00    11  2       28.00       3 24    365 365     108.80       84.55
1963     1160.00     5 21       30.90       3 11    365 365     164.75      196.83
1964      544.00    12 28       16.00       9 18    366 366      67.10       83.77
1965      399.00     5 19       16.70       8  7    365 365      85.07       74.61
1966      515.00     4 23       13.90       9  2    365 365      84.07       88.43
1967      702.00     5 13       18.00       3 14    365 365     107.56      126.20
1968      725.00     4 15       10.90       9 22    366 366      96.39      136.70
1969      841.00    12 30       19.60       9  5    365 365     133.39      164.40
1970     1520.00     2  5       37.90       8  1    365 365     126.40      140.18
1971      881.00     5  5       16.90      10  4    365 365      96.39      156.07
1972     1110.00     5 17       22.60       2 14    366 366     135.96      177.56
1973     2190.00     4 30       23.00      10 30    365 365     153.34      217.26
1974     1090.00     5  2       27.70       9  3    365 365     126.62      144.60
1975      784.00     5  8       19.30       9  4    365 365     111.14      145.56
1976      765.00     4  3       26.60      12 26    366 366     150.23      146.89
1977      980.00     4 24       21.00       2 28    365 365     130.50      139.71
1978      821.00     5 11       18.00       9 28    365 365      96.28      126.54
1979     1450.00     5  1       20.10       1  2    365 365     163.51      195.46
1980      603.00     4 24       20.40       3  7    366 366     111.18       99.63
1981      847.00     4 11       20.70       9  8    365 365     140.97      126.72
1982     1060.00     4 28       26.00       8 23    365 365     110.49      134.67
1983     1010.00     4 19       22.20      10  4    365 365     126.49      148.17


     STATION 01BO001 COMPLETED.     41 YEARS PROCESSED.   1387 RECORDS PROCESSED.
  RECORDS SKIPPED : WRONG DATA:     0. WRONG SEQUENCE:     0. YEAR NOT WANTED:     0. MONTH NOT WANTED:     0
```

```
STATION :    01BO001     FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.       0 DAYS.

  FLOW,CMS  %MAX-MIN %GREATER #GREATER        FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

   2190.00    100.00      0.00          0  |
   2168.19     99.00      0.01          1  |
   2146.39     98.00      0.01          1  |
   2080.97     95.00      0.01          1  |
   1971.93     90.00      0.01          2  |
   1862.90     85.00      0.02          3  |
   1753.87     80.00      0.02          3  |
   1644.83     75.00      0.02          3  |
   1535.80     70.00      0.02          3  |
   1426.77     65.00      0.04          6  |
   1317.74     60.00      0.05          7  |
   1208.70     55.00      0.06          8  |
   1099.67     50.00      0.09         13  |
    990.64     45.00      0.22         31  |
    881.60     40.00      0.42         59  |
    772.57     35.00      0.85        120  |
    663.54     30.00      1.45        204  |*
    609.02     27.50      2.01        283  |*
    554.50     25.00      2.73        384  |*
    499.99     22.50      3.53        496  |**
    445.47     20.00      4.48        629  |**
    390.96     17.50      5.74        807  |***
    336.44     15.00      7.48       1051  |****
    281.92     12.50      9.79       1376  |****$
    227.41     10.00     13.04       1833  |****$**
    205.60      9.00     14.92       2096  |****$**
    183.79      8.00     17.09       2402  |****$****
    161.99      7.00     19.76       2777  |****$****$
    140.18      6.00     22.99       3230  |****$****$*
    118.37      5.00     27.48       3862  |****$****$****
    107.47      4.50     30.26       4252  |****$****$****$
     96.57      4.00     33.23       4670  |****$****$****$**
     85.66      3.50     37.63       5288  |****$****$****$****
     74.76      3.00     42.97       6038  |****$****$****$****$*
     63.86      2.50     49.45       6949  |****$****$****$****$****$
     52.95      2.00     57.64       8100  |****$****$****$****$****$****
     48.59      1.80     61.91       8699  |****$****$****$****$****$****$*
     44.23      1.60     66.50       9345  |****$****$****$****$****$****$***
     39.87      1.40     71.77      10085  |****$****$****$****$****$****$****$*
     35.51      1.20     77.08      10831  |****$****$****$****$****$****$****$****
     31.15      1.00     82.73      11625  |****$****$****$****$****$****$****$****$*
     28.97      0.90     85.80      12056  |****$****$****$****$****$****$****$****$***
     26.79      0.80     89.29      12547  |****$****$****$****$****$****$****$****$****$
     24.60      9.70     91.71      12887  |****$****$****$****$****$****$****$****$****$*
     22.42      0.60     94.45      13272  |****$****$****$****$****$****$****$****$****$**
     20.24      0.50     96.22      13521  |****$****$****$****$****$****$****$****$****$***
     18.06      0.40     97.78      13740  |****$****$****$****$****$****$****$****$****$****
     15.88      0.30     98.82      13886  |****$****$****$****$****$****$****$****$****$****
     13.70      0.20     99.42      13970  |****$****$****$****$****$****$****$****$****$****$
     11.52      0.10     99.85      14031  |****$****$****$****$****$****$****$****$****$****$
      9.34     -0.00    100.00      14052  |****$****$****$****$****$****$****$****$****$****$
                                           0---10---20---30---40---50---60---70---80---90--100
```

SOUTHWEST MIRAMICHI
RIVER AT BLACKVILLE

Drainage Area 5,050 km^2
Natural Flow

RENOUS RIVER AT MCGRAW BROOK

```
STATION :   01BO002    FLOW
MONTHS SELECTED :   ALL MONTHS.
YEARS SELECTED :    ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.     0 DAYS.

YEAR     MAX       MON DY     MIN        MON DY   TOT DAYS     MEAN        STD       MISSED
      FLOW,CMS              FLOW,CMS            DAY USED   FLOW,CMS   DEVIATION    MONTHS

1965     33.40     11 19       2.83       9 20   122 109      10.23       6.56     1  2  3  4  5  6  7  8
1966     86.10      5 21       0.83       8 30   365 365      11.43      14.22
1967     81.00      5 20       0.74       8 27   365 365      13.05      17.09
1968    102.00      4 26       0.68       9 20   366 366      10.85      17.28
1969    141.00      9 10       0.82       9  5   365 365      15.98      23.07
1970    320.00      2  4       2.60       8  1   365 365      16.81      26.75
1971    150.00      5  5       0.79      10  5   365 365      11.31      21.81
1972    181.00      5 16       1.81       2 13   366 366      18.55      26.18
1973    306.00      4 29       1.37       9 17   365 365      17.05      27.08
1974    142.00      4 30       1.29       9  2   365 365      15.69      22.16
1975    119.00      5 13       1.04       8 11   365 365      13.15      19.62
1976    108.00      5 13       2.71       7 11   366 366      19.68      20.86
1977    122.00      4 23       1.23       9 13   365 365      16.34      20.50
1978    125.00      5 10       0.76       9  6   365 365      10.93      18.73
1979    249.00      4 30       1.28       8 12   365 365      20.80      30.38
1980    121.00      4 24       1.57       3  7   366 366      13.90      15.16
1981    120.00      4  6       2.10       9  8   365 365      17.71      16.66
1982    144.00      4 28       2.53       3  5   365 365      13.72      19.32
1983    190.00      4 18       1.35       8 26   365 365      15.46      21.87

      STATION 01BO002 COMPLETED,     19 YEARS PROCESSED,    661 RECORDS PROCESSED.
 RECORDS SKIPPED ; WRONG DATA:     0, WRONG SEQUENCE:     0, YEAR NOT WANTED:     0, MONTH NOT WANTED:     0
```

```
STATION :   01BO002    FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %. I.E.      0 DAYS.

  FLOW,CMS  %MAX-MIN %GREATER #GREATER       FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

    320.00   100.00     0.00        0  I
    316.81    99.00     0.01        1  I
    313.61    98.00     0.01        1  I
    304.03    95.00     0.03        2  I
    288.07    90.00     0.03        2  I
    272.10    85.00     0.03        2  I
    256.14    80.00     0.03        2  I
    240.17    75.00     0.04        3  I
    224.20    70.00     0.06        4  I
    208.24    65.00     0.06        4  I
    192.27    60.00     0.09        6  I
    176.30    55.00     0.15       10  I
    160.34    50.00     0.21       14  I
    144.37    45.00     0.25       17  I
    128.41    40.00     0.48       32  I
    112.44    35.00     0.79       53  I
     96.47    30.00     1.21       81  I*
     88.49    27.50     1.68      112  I*
     80.51    25.00     2.23      149  I*
     72.52    22.50     2.87      192  I*
     64.54    20.00     3.88      259  I**
     56.56    17.50     5.34      357  I***
     48.58    15.00     6.99      467  I***
     40.59    12.50     8.87      593  I****
     32.61    10.00    11.75      785  I****$*
     29.42     9.00    13.11      876  I****$**
     26.22     8.00    14.90      996  I****$**
     23.03     7.00    17.33     1158  I****$****
     19.84     6.00    20.08     1342  I****$****$
     16.64     5.00    24.35     1627  I****$****$**
     15.05     4.50    26.92     1799  I****$****$***
     13.45     4.00    30.11     2012  I****$****$****$
     11.85     3.50    33.97     2270  I****$****$****$**
     10.26     3.00    38.23     2555  I****$****$****$****
      8.66     2.50    43.75     2924  I****$****$****$****$**
      7.06     2.00    51.59     3448  I****$****$****$****$****$*
      6.42     1.80    55.18     3688  I****$****$****$****$****$***
      5.79     1.60    58.93     3938  I****$****$****$****$****$****
      5.15     1.40    63.65     4254  I****$****$****$****$****$****$**
      4.51     1.20    69.22     4626  I****$****$****$****$****$****$****$
      3.87     1.00    74.97     5010  I****$****$****$****$****$****$****$**
      3.55     0.90    78.06     5217  I****$****$****$****$****$****$****$****
      3.23     0.80    81.03     5415  I****$****$****$****$****$****$****$****$*
      2.91     0.70    84.72     5662  I****$****$****$****$****$****$****$****$**
      2.59     0.60    87.80     5868  I****$****$****$****$****$****$****$****$****
      2.27     0.50    90.98     6080  I****$****$****$****$****$****$****$****$****$
      1.95     0.40    93.51     6249  I****$****$****$****$****$****$****$****$****$**
      1.63     0.30    95.84     6405  I****$****$****$****$****$****$****$****$****$***
      1.32     0.20    97.40     6509  I****$****$****$****$****$****$****$****$****$****
      1.00     0.10    98.76     6600  I****$****$****$****$****$****$****$****$****$****
      0.68    -0.00   100.00     6683  I****$****$****$****$****$****$****$****$****$****$
                                       0---10---20---30---40---50---60---70---80---90--100
```

RENOUS RIVER AT
MCGRAW BROOK

Drainage Area 611 km^2
Natural Flow

```
STATION :   01BD003    FLOW                      BARNABY RIVER BELOW SEMIWAGAN RIVER
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.      0 DAYS.

 YEAR        MAX       MON DY       MIN        MON DY    TOT DAYS     MEAN        STD       MISSED
          FLOW,CMS               FLOW,CMS              DAY USED   FLOW,CMS   DEVIATION    MONTHS


 1973        85.20      4 19        0.29        9  2    365 365      10.12       14.91
 1974       178.00     12 10        0.70        2 19    365 365      10.49       18.10
 1975       144.00      5  8        0.36        9  5    365 365       9.62       18.44
 1976        70.80      4  4        0.78        7 11    366 366      10.85       12.87
 1977       186.00      4 23        0.55        9  4    365 365      14.61       23.60
 1978        64.00      5 10        0.27        8 27    365 365       6.35       11.26
 1979       102.00      4 11        0.67        7 26    365 365      12.48       16.38
 1980       160.00      4 24        0.50        2 17    366 366      10.02       14.46
 1981       147.00      4  6        0.90        9  9    365 365      14.87       18.61
 1982        95.10      4 19        1.20        7 20    365 365       8.75       13.02
 1983        61.30      6  1        0.63        8 27    365 365       8.48       11.07


     STATION 01BD003 COMPLETED,    11 YEARS PROCESSED,   397 RECORDS PROCESSED.
  RECORDS SKIPPED ; WRONG DATA:    0, WRONG SEQUENCE:    0, YEAR NOT WANTED:    0, MONTH NOT WANTED:    0
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STATION :   01B0003    FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.      0 DAYS.

   FLOW,CMS  %MAX-MIN %GREATER #GREATER       .  FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

     186.00   100.00     0.00        0  I
     184.14    99.00     0.02        1  I
     182.29    98.00     0.02        1  I
     176.71    95.00     0.05        2  I
     167.43    90.00     0.05        2  I
     158.14    85.00     0.10        4  I
     148.85    80.00     0.10        4  I
     139.57    75.00     0.17        7  I
     130.28    70.00     0.20        8  I
     121.00    65.00     0.22        9  I
     111.71    60.00     0.27       11  I
     102.42    55.00     0.27       11  I
      93.14    50.00     0.50       20  I
      83.85    45.00     0.80       32  I
      74.56    40.00     1.12       45  I*
      65.28    35.00     1.74       70  I*
      55.99    30.00     2.84      114  I*
      51.35    27.50     3.44      138  I**
      46.70    25.00     4.26      171  I**
      42.06    22.50     5.40      217  I***
      37.42    20.00     6.50      261  I***
      32.77    17.50     7.94      319  I****
      28.13    15.00     9.91      398  I****$
      23.49    12.50    12.45      500  I****$*
      18.84    10.00    16.23      652  I****$***
      16.99     9.00    18.15      729  I****$****
      15.13     8.00    19.74      793  I****$****$
      13.27     7.00    22.53      905  I****$****$*
      11.42     6.00    25.59     1028  I****$****$***
       9.56     5.00    29.20     1173  I****$****$****$
       8.63     4.50    31.72     1274  I****$****$****$*
       7.70     4.00    34.70     1394  I****$****$****$**
       6.77     3.50    38.46     1545  I****$****$****$****
       5.84     3.00    42.30     1699  I****$****$****$****$*
       4.92     2.50    47.27     1899  I****$****$****$****$****
       3.99     2.00    53.07     2132  I****$****$****$****$****$**
       3.62     1.80    56.09     2253  I****$****$****$****$****$***
       3.24     1.60    59.30     2382  I****$****$****$****$****$****$
       2.87     1.40    62.68     2518  I****$****$****$****$****$****$*
       2.50     1.20    66.64     2677  I****$****$****$****$****$****$***
       2.13     1.00    71.84     2886  I****$****$****$****$****$****$****$*
       1.94     0.90    74.48     2992  I****$****$****$****$****$****$****$**
       1.76     0.80    77.17     3100  I****$****$****$****$****$****$****$****
       1.57     0.70    80.11     3218  I****$****$****$****$****$****$****$****$
       1.39     0.60    83.69     3362  I****$****$****$****$****$****$****$****$**
       1.20     0.50    87.13     3500  I****$****$****$****$****$****$****$****$****
       1.01     0.40    90.19     3623  I****$****$****$****$****$****$****$****$****$
       0.83     0.30    92.66     3722  I****$****$****$****$****$****$****$****$****$*
       0.64     0.20    95.02     3817  I****$****$****$****$****$****$****$****$****$***
       0.46     0.10    98.33     3950  I****$****$****$****$****$****$****$****$****$****
       0.27    -0.00   100.00     4017  I****$****$****$****$****$****$****$****$****$****$
                                        0---10---20---30---40---50---60---70---80---90--100
```

BARNABY RIVER BELOW
SEMIWAGAN RIVER

Drainage Area 484 km^2
Natural Flow

```
STATION :   01BO004    FLOW                      BARTIBOG RIVER BELOW HIGHWAY NO. 8
MONTHS SELECTED :   ALL MONTHS.
YEARS SELECTED :    ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.      0 DAYS.

 YEAR       MAX      MON DY       MIN       MON DY     TOT DAYS      MEAN        STD       MISSED
         FLOW,CMS              FLOW,CMS                DAY USED    FLOW,CMS   DEVIATION    MONTHS

 1978        1.12    12 29        0.69      11 11       61  54       0.89        0.11      1  2  3  4  5  6  7  8  9 10
 1979      111.00     5  1        1.02       1  1      365 365       9.73       12.70
 1980      174.00     4 24        0.98       3  7      366 366       9.12       14.01
 1981       87.70     4  6        1.07       2  2      365 365      11.21       11.87
 1982       73.30     4 28        2.21       3  3      365 365       7.23        8.30
 1983       62.30     4 26        1.72      11  2      365 365       7.99        9.27


      STATION 01BO004 COMPLETED.     6 YEARS PROCESSED.   187 RECORDS PROCESSED.
 RECORDS SKIPPED ; WRONG DATA:    0, WRONG SEQUENCE:    0, YEAR NOT WANTED:    0, MONTH NOT WANTED:    0
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```
STATION :   01BD004    FLOW
MONTHS SELECTED :   ALL MONTHS.
YEARS SELECTED :    ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.     0 DAYS.

  FLOW,CMS  %MAX-MIN %GREATER #GREATER       FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

    174.00   100.00    0.00       0  |
    172.27    99.00    0.05       1  |
    170.53    98.00    0.05       1  |
    165.33    95.00    0.05       1  |
    156.67    90.00    0.05       1  |
    148.00    85.00    0.05       1  |
    139.34    80.00    0.05       1  |
    130.67    75.00    0.05       1  |
    122.01    70.00    0.05       1  |
    113.34    65.00    0.05       1  |
    104.68    60.00    0.11       2  |
     96.01    55.00    0.11       2  |
     87.35    50.00    0.16       3  |
     78.68    45.00    0.37       7  |
     70.02    40.00    0.59      11  |
     61.35    35.00    0.96      18  |
     52.69    30.00    1.12      21  |*
     48.35    27.50    1.44      27  |*
     44.02    25.00    2.07      39  |*
     39.69    22.50    2.71      51  |*
     35.36    20.00    3.51      66  |**
     31.02    17.50    4.68      88  |**
     26.69    15.00    6.28     118  |***
     22.36    12.50    7.77     146  |****
     18.02    10.00   10.37     195  |****$
     16.29     9.00   12.34     232  |****$*
     14.56     8.00   14.41     271  |****$**
     12.83     7.00   17.23     324  |****$****
     11.09     6.00   21.12     397  |****$****$*
      9.36     5.00   26.54     499  |****$****$***
      8.49     4.50   29.89     562  |****$****$****$
      7.63     4.00   33.88     637  |****$****$****$**
      6.76     3.50   39.31     739  |****$****$****$****$
      5.89     3.00   44.41     835  |****$****$****$****$**
      5.03     2.50   51.06     960  |****$****$****$****$****$*
      4.16     2.00   58.62    1102  |****$****$****$****$****$****
      3.81     1.80   62.82    1181  |****$****$****$****$****$****$*
      3.47     1.60   67.61    1271  |****$****$****$****$****$****$****
      3.12     1.40   72.98    1372  |****$****$****$****$****$****$****$*
      2.77     1.20   77.98    1466  |****$****$****$****$****$****$****$****
      2.43     1.00   83.83    1576  |****$****$****$****$****$****$****$****$**
      2.26     0.90   86.54    1627  |****$****$****$****$****$****$****$****$***
      2.08     0.80   89.84    1689  |****$****$****$****$****$****$****$****$****$
      1.91     0.70   92.07    1731  |****$****$****$****$****$****$****$****$****$*
      1.73     0.60   93.62    1760  |****$****$****$****$****$****$****$****$****$**
      1.56     0.50   94.36    1774  |****$****$****$****$****$****$****$****$****$**
      1.39     0.40   95.16    1789  |****$****$****$****$****$****$****$****$****$***
      1.21     0.30   96.12    1807  |****$****$****$****$****$****$****$****$****$***
      1.04     0.20   97.02    1824  |****$****$****$****$****$****$****$****$****$****
      0.87     0.10   98.67    1855  |****$****$****$****$****$****$****$****$****$****
      0.69    -0.00  100.00    1880  |****$****$****$****$****$****$****$****$****$****$
                                     0---10---20---30---40---50---60---70---80---90--100
```

BARTIBOG RIVER BELOW
HIGHWAY NO. 8

Drainage Area 316 km^2
Natural Flow

```
STATION :   01BP001     FLOW            LITTLE SOUTHWEST MIRAMICHI RIVER AT LYTTLETON
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.      0 DAYS.

 YEAR      MAX       MON DY       MIN       MON DY    TOT DAYS     MEAN        STD       MISSED
        FLOW,CMS              FLOW,CMS               DAY USED   FLOW,CMS   DEVIATION    MONTHS


 1951     147.00      7 13        6.85      10 20    214 207      21.77       19.30     1  2  3  4  5
 1952     199.00      5 22        4.59       9 19    366 366      35.37       42.01
 1953     263.00      4  2        3.20      10  7    365 365      35.97       46.39
 1954     267.00      9 12        2.63       2  1    365 365      41.49       40.28
 1955     185.00      5 30        4.05       2 10    365 365      31.25       40.35
 1956     190.00      1 14        4.73       1  3    366 366      27.41       32.78
 1957     237.00     12 28        3.17       1 17    365 365      30.64       39.91
 1958     314.00      4 25        3.51      12 30    365 365      39.79       45.79
 1959     148.00     10 26        1.70       1 14    365 365      26.33       30.42
 1960     422.00      5 15        2.61       8 29    366 366      31.24       50.16
 1961     861.00      5 28        4.87       2 24    365 365      34.19       69.17
 1962     139.00     11  2        8.64       3 22    365 365      28.81       21.06
 1963     416.00     11  9        7.08       3 16    365 365      42.38       48.82
 1964     193.00      5 23        4.42      10 13    366 366      20.91       27.06
 1965     138.00      5 17        4.56       8 16    365 365      22.26       20.94
 1966     150.00      5 23        3.17       9 14    365 365      24.83       26.41
 1967     114.00      5 27        4.79       9 22    365 365      27.80       27.36
 1968     174.00      4 15        3.74       9 22    366 366      23.15       30.73
 1969     467.00      5 21        5.95       3  8    365 365      37.63       50.99
 1970     708.00      2  4        8.13       2 27    365 365      39.88       59.68
 1971     230.00      5  5        4.45      10  5    365 365      25.16       39.32
 1972     371.00      5 19        5.01       3  4    366 366      39.98       51.06
 1973     510.00      4 29        6.54      10 30    365 365      40.25       56.31
 1974     213.00      5 16        7.90       9  3    365 365      32.22       35.32
 1975     218.00      5 14        5.35       9  3    365 365      28.89       40.35
 1976     250.00      5 13        8.78       3 21    366 366      44.98       45.13
 1977     238.00      4 22        4.53       3  9    365 365      37.26       41.26
 1978     212.00      5 11        4.73      10  2    365 365      27.21       39.51
 1979     552.00      4 30        5.66       1  1    365 365      45.05       65.29
 1980     200.00      4 24        5.52       3  8    366 366      32.26       28.84
 1981     206.00      5 14        8.00       2  1    365 365      40.08       35.55
 1982     195.00      4 28        4.45       3  7    365 365      32.28       32.55
 1983     210.00      4 19        8.60       1 10    365 365      34.81       35.61


     STATION 01BP001 COMPLETED,     33 YEARS PROCESSED,  1174 RECORDS PROCESSED.
  RECORDS SKIPPED ; WRONG DATA:     0, WRONG SEQUENCE:     0, YEAR NOT WANTED:     0, MONTH NOT WANTED:     0
```

```
STATION :    01BP001     FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.      0 DAYS.

   FLOW,CMS  %MAX-MIN %GREATER #GREATER       FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

    861.00    100.00      0.00        0  |
    852.41     99.00      0.01        1  |
    843.81     98.00      0.01        1  |
    818.03     95.00      0.01        1  |
    775.07     90.00      0.01        1  |
    732.10     85.00      0.01        1  |
    689.14     80.00      0.02        2  |
    646.17     75.00      0.02        2  |
    603.21     70.00      0.02        2  |
    560.24     65.00      0.02        2  |
    517.28     60.00      0.03        4  |
    474.31     55.00      0.05        6  |
    431.35     50.00      0.07        8  |
    388.38     45.00      0.10       12  |
    345.42     40.00      0.13       16  |
    302.45     35.00      0.21       25  |
    259.49     30.00      0.34       41  |
    238.01     27.50      0.41       49  |
    216.52     25.00      0.61       72  |
    195.04     22.50      1.07      127  |*
    173.56     20.00      1.55      184  |*
    152.08     17.50      2.39      284  |*
    130.59     15.00      3.93      468  |**
    109.11     12.50      6.12      728  |***
     87.63     10.00      9.14     1087  |****$
     79.04      9.00     10.67     1269  |****$
     70.44      8.00     12.11     1441  |****$*
     61.85      7.00     14.09     1676  |****$**
     53.26      6.00     16.80     1998  |****$***
     44.66      5.00     20.58     2448  |****$****$
     40.37      4.50     22.79     2711  |****$****$*
     36.07      4.00     25.58     3043  |****$****$***
     31.78      3.50     28.90     3438  |****$****$****
     27.48      3.00     33.16     3944  |****$****$****$**
     23.18      2.50     38.98     4637  |****$****$****$****
     18.89      2.00     46.71     5556  |****$****$****$****$***
     17.17      1.80     50.25     5977  |****$****$****$****$****$
     15.45      1.60     54.80     6519  |****$****$****$****$****$**
     13.73      1.40     60.06     7144  |****$****$****$****$****$****$
     12.01      1.20     65.98     7848  |****$****$****$****$****$****$***
     10.29      1.00     73.36     8726  |****$****$****$****$****$****$****$**
      9.43      0.90     77.14     9176  |****$****$****$****$****$****$****$****
      8.57      0.80     81.20     9659  |****$****$****$****$****$****$****$****$*
      7.72      0.70     84.93    10103  |****$****$****$****$****$****$****$****$**
      6.86      0.60     89.53    10649  |****$****$****$****$****$****$****$****$****$
      6.00      0.50     93.17    11083  |****$****$****$****$****$****$****$****$****$**
      5.14      0.40     96.08    11429  |****$****$****$****$****$****$****$****$****$***
      4.28      0.30     98.52    11719  |****$****$****$****$****$****$****$****$****$****
      3.42      0.20     99.39    11823  |****$****$****$****$****$****$****$****$****$****$
      2.56      0.10     99.87    11880  |****$****$****$****$****$****$****$****$****$****$
      1.70     -0.00    100.00    11895  |****$****$****$****$****$****$****$****$****$****$
                                         0---10---20---30---40---50---60---70---80---90--100
```

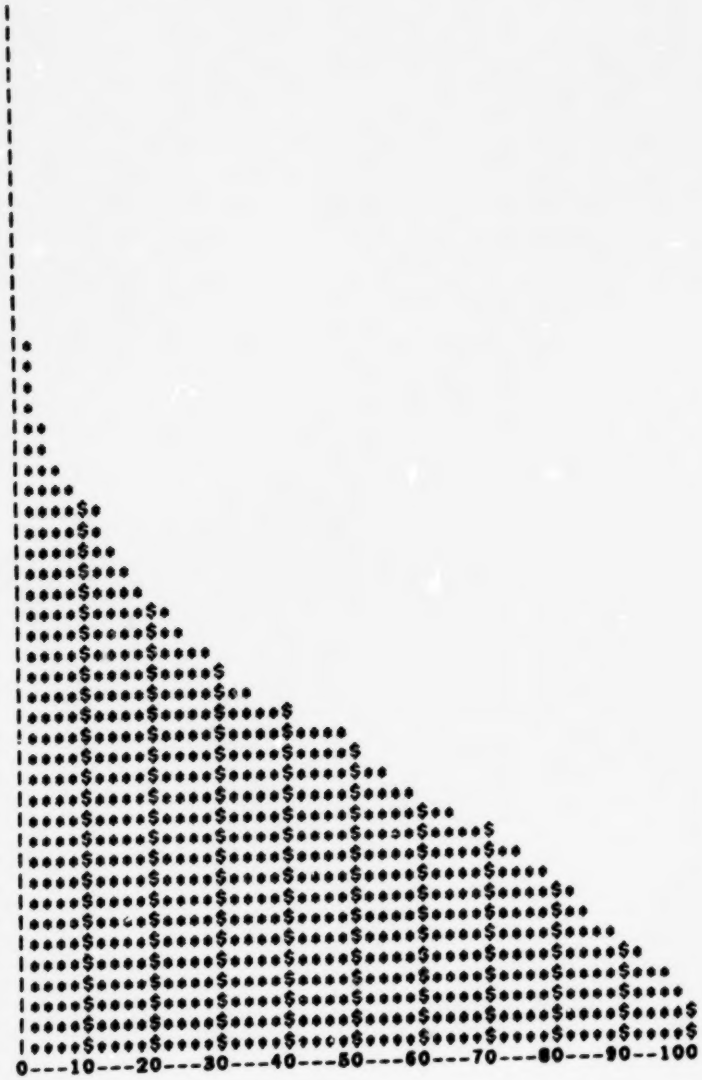
LITTLE SOUTHWEST
MIRAMICHI RIVER AT
LYTTLETON

Drainage Area 1,340 km^2
Natural Flow

```
STATION :   01BQ001     FLOW                         NORTHWEST MIRAMICHI RIVER AT TROUT BROOK
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.       0 DAYS.

 YEAR        MAX       MON DY        MIN        MON DY      TOT DAYS      MEAN         STD        MISSED
          FLOW,CMS               FLOW,CMS                   DAY USED    FLOW,CMS    DEVIATION    MONTHS

 1961        34.00     11 29          5.58      10  2        92  92        14.69         6.17      1  2  3  4  5  6  7  8  9
 1962       114.00     11  2          4.64       6 30       365 365        23.07        19.06
 1963       289.00      5 20          4.05       3 19       365 365        31.07        43.77
 1964       155.00      5 10          3.03       4  4       366 366        12.88        19.31
 1965        72.50      5 18          3.68       8  7       365 365        15.40        14.61
 1966       116.00      5 21          2.66       9  1       365 365        17.08        20.52
 1967       129.00      5 13          2.55       8 27       365 365        19.30        27.24
 1968       124.00      4 26          2.19      10 17       366 366        15.45        22.15
 1969       202.00      5 21          3.65       9  5       365 365        26.06        34.97
 1970       487.00      2  4          3.65       8 11       365 365        24.55        40.03
 1971       206.00      5  5          2.25       3 11       365 365        17.74        32.02
 1972       236.00      5 19          2.83       2 12       366 366        22.91        31.02
 1973       388.00      4 29          2.45      10 30       365 365        25.38        40.94
 1974       187.00     12 10          2.83       2 17       365 365        21.55        29.74
 1975       200.00      5 13          2.42      10 11       365 365        19.28        33.12
 1976       176.00      4  3          3.45      12 26       366 366        27.84        32.85
 1977       196.00      4 23          2.44       9 13       365 365        25.80        34.98
 1978       191.00      5 11          1.56      12 31       365 365        15.78        28.24
 1979       445.00      4 30          3.29       8 12       365 365        20.53        45.04
 1980       274.00      4 24          2.66       3  8       366 366        24.24        29.33
 1981       160.00      4  6          4.19       8  3       365 365        27.37        26.54
 1982       191.00      4 28          3.10       3  5       365 365        19.88        24.68
 1983       245.00      4 18          2.44       9 17       365 365        22.21        31.24


      STATION 01BQ001 COMPLETED,     23 YEARS PROCESSED,    802 RECORDS PROCESSED.
  RECORDS SKIPPED ; WRONG DATA:     0, WRONG SEQUENCE:     0, YEAR NOT WANTED:     0, MONTH NOT WANTED:     0
```

```
STATION :   01BQ001     FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %. I.E.      0 DAYS.

   FLOW,CMS  %MAX-MIN %GREATER #GREATER

     487.00   100.00     0.00       0
     482.15    99.00     0.01       1
     477.29    98.00     0.01       1
     462.73    95.00     0.01       1
     438.46    90.00     0.02       2
     414.18    85.00     0.02       2
     389.91    80.00     0.02       2
     365.64    75.00     0.04       3
     341.37    70.00     0.05       4
     317.10    65.00     0.06       5
     292.82    60.00     0.10       8
     268.55    55.00     0.12      10
     244.28    50.00     0.16      13
     220.01    45.00     0.23      19
     195.74    40.00     0.34      28
     171.46    35.00     0.59      48
     147.19    30.00     1.10      89
     135.06    27.50     1.37     111
     122.92    25.00     1.85     150
     110.78    22.50     2.61     212
      98.65    20.00     3.54     288
      86.51    17.50     4.92     400
      74.38    15.00     6.84     556
      62.24    12.50     8.76     712
      50.10    10.00    11.14     905
      45.25     9.00    12.70    1032
      40.40     8.00    14.10    1146
      35.54     7.00    16.09    1308
      30.69     6.00    18.56    1508
      25.83     5.00    22.03    1790
      23.40     4.50    24.20    1967
      20.98     4.00    27.06    2199
      18.55     3.50    30.34    2466
      16.12     3.00    34.21    2780
      13.70     2.50    39.99    3250
      11.27     2.00    47.09    3827
      10.30     1.80    50.51    4105
       9.33     1.60    54.19    4404
       8.36     1.40    58.71    4771
       7.39     1.20    63.95    5197
       6.41     1.00    70.49    5729
       5.93     0.90    74.12    6024
       5.44     0.80    77.51    6299
       4.96     0.70    81.05    6587
       4.47     0.60    84.91    6901
       3.99     0.50    88.94    7228
       3.50     0.40    92.47    7515
       3.02     0.30    96.33    7829
       2.53     0.20    98.84    8033
       2.05     0.10    99.82    8112
       1.56    -0.00   100.00    8127
```

FLOW,CMS. VS. % GREATER THAN GIVEN FLOW



NORTHWEST MIRAMICHI
RIVER AT TROUT BROOK

Drainage Area 948 km^2
Natural Flow

```
STATION :   01BQ007     FLOW                 TOMOGONOPS RIVER AT THE MOUTH
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :    0 %, I.E.      0 DAYS.

YEAR        MAX       MON DY       MIN        MON DY    TOT DAYS     MEAN        STD        MISSED
          FLOW,CMS               FLOW,CMS               DAY USED   FLOW,CMS   DEVIATION     MONTHS


1972        41.10      5 19        0.42        2 11    366 366       3.96        5.14
1973        88.60      4 29        0.51       10 29    365 365       4.23        7.60
1974        44.20      5 16        0.56        8 23    365 365       4.27        7.02
1975        30.80      5 13        0.40       10 11    365 365       3.67        6.51
1976        25.40      5 13        0.59       12 25    366 366       4.56        4.94
1977        27.00      5 14        0.40        3  6    365 365       4.41        5.61
1978        36.00      5 11        0.26       12 31    365 365       2.81        5.35
1979        34.00      3 27        0.25        1  1     90  90       3.52        5.94      4  5  6  7  8  9 10 11 12


     STATION 01BQ007 COMPLETED.      8 YEARS PROCESSED.   262 RECORDS PROCESSED.
   RECORDS SKIPPED ; WRONG DATA:    0, WRONG SEQUENCE:    0, YEAR NOT WANTED:    0, MONTH NOT WANTED:    0
```

```
STATION :    01BQ007     FLOW
MONTHS SELECTED :    ALL MONTHS.
YEARS SELECTED :     ALL YEARS.
GOOD DATA REQUIRED FOR ANALYSIS :     0 %, I.E.      0 DAYS.

  FLOW,CMS   %MAX-MIN %GREATER #GREATER       FLOW,CMS.  VS.  % GREATER THAN GIVEN FLOW

    88.60    100.00     0.00       0   |
    87.72     99.00     0.04       1   |
    86.83     98.00     0.04       1   |
    84.18     95.00     0.04       1   |
    79.77     90.00     0.04       1   |
    75.35     85.00     0.04       1   |
    70.93     80.00     0.04       1   |
    66.51     75.00     0.04       1   |
    62.10     70.00     0.04       1   |
    57.68     65.00     0.04       1   |
    53.26     60.00     0.04       1   |
    48.84     55.00     0.04       1   |
    44.43     50.00     0.11       3   |
    40.01     45.00     0.23       6   |
    35.59     40.00     0.53      14   |
    31.18     35.00     0.79      21   |
    26.76     30.00     1.59      42   |*
    24.55     27.50     2.00      53   |*
    22.34     25.00     2.57      68   |*
    20.13     22.50     3.25      86   |**
    17.92     20.00     4.27     113   |**
    15.72     17.50     5.89     156   |***
    13.51     15.00     7.48     198   |****
    11.30     12.50     9.63     255   |*****$
     9.09     10.00    11.98     317   |*****$*
     8.21      9.00    12.96     343   |*****$*
     7.32      8.00    14.05     372   |*****$**
     6.44      7.00    15.75     417   |*****$***
     5.56      6.00    17.83     472   |*****$****
     4.67      5.00    20.21     535   |*****$*****$
     4.23      4.50    22.21     588   |*****$*****$*
     3.79      4.00    24.86     658   |*****$*****$**
     3.35      3.50    28.03     742   |*****$*****$****
     2.91      3.00    32.15     851   |*****$*****$*****$*
     2.46      2.50    36.76     973   |*****$*****$*****$***
     2.02      2.00    43.18    1143   |*****$*****$*****$*****$**
     1.85      1.80    46.54    1232   |*****$*****$*****$*****$***
     1.67      1.60    50.66    1341   |*****$*****$*****$*****$*****$
     1.49      1.40    55.35    1465   |*****$*****$*****$*****$*****$***
     1.32      1.20    61.39    1625   |*****$*****$*****$*****$*****$*****$*
     1.14      1.00    67.09    1776   |*****$*****$*****$*****$*****$*****$****
     1.05      0.90    69.70    1845   |*****$*****$*****$*****$*****$*****$*****$
     0.96      0.80    73.78    1953   |*****$*****$*****$*****$*****$*****$*****$**
     0.87      0.70    78.20    2070   |*****$*****$*****$*****$*****$*****$*****$****
     0.79      0.60    83.30    2205   |*****$*****$*****$*****$*****$*****$*****$*****$**
     0.70      0.50    87.34    2312   |*****$*****$*****$*****$*****$*****$*****$*****$****
     0.61      0.40    90.78    2403   |*****$*****$*****$*****$*****$*****$*****$*****$*****$
     0.52      0.30    93.46    2474   |*****$*****$*****$*****$*****$*****$*****$*****$*****$**
     0.43      0.20    96.64    2558   |*****$*****$*****$*****$*****$*****$*****$*****$*****$***
     0.34      0.10    98.83    2616   |*****$*****$*****$*****$*****$*****$*****$*****$*****$****
     0.25     -0.00   100.00    2647   |*****$*****$*****$*****$*****$*****$*****$*****$*****$*****$
                                       0---10---20---30---40---50---60---70---80---90--100
```

TOMOGONOPS RIVER
AT THE MOUTH

Drainage Area 158 km^2
Regulated Flow

APPENDIX F

LOWFLOW FREQUENCY CURVES OF HYDROMETRIC STATIONS IN THE REGION

Introduction:

Low flow characteristics are commonly used to evaluate the adequacy of a stream in supplying the requirements for municipal and industrial water supplies, supplemental irrigation, maintenance of suitable conditions for fish, and waste disposal. These characteristics may be estimated, at a gauging station, by frequency curves, and by base-flow recession curves. Estimates of low flow characteristics for ungauged sites are generally quite inaccurate because low flow is highly dependent on the geology and the amount of evapotranspiration. However, estimates may be made if a few discharge measurements of base flow during one or more low flow seasons are available. Also, such estimates may be made from regionalized low flow frequency curves.

The reliability of low flow frequency curves which are based on natural flows is closely related to the period of record used in the analysis. Plans for utilization of low flows of a stream commonly are based on the low flows that have recurrence intervals of not more than 20 years of record are considered desirable. It was shown by (Riggs, 1972) that useful estimates of the 20-year annual minimum flow may be obtained by extrapolating flow frequency curves based on 10 or more years of record.

On the other hand, less than 10 annual events at a particular station are usually inadequate to define a low flow frequency curve. Such a station provides insufficient data for proper correlation with the concurrent part of a nearby station having a longer period of record. However, the relation between concurrent events (either annual minimums, daily mean base flows, or discharge measurements of base flows) can be used along with the frequency curve for the station that has the longer record, to approximate the 20-year annual minimum flow for the short record station.

In this appendix,four stations were selected for low flow analysis. The selection was made on the basis of the length of record, and only stations with ten years of record or more were selected. The stations used experienced natural flow conditions during their record periods.

Low flow frequency analysis was performed for the selected stations. Recurrence intervals of 1.05, 2, 5, 10, 20, 50, and 100 years were considered for durations of 1, 3, 7, 14, 30, 60, 90, and 120 days. The low flows and the unit low flows as well as the low flow frequency curves for each of the selected stations are presented in this appendix.

Reference:

Riggs, H.C. (1972), Techniques of Water Resources Investigations of the United States Geological Survey, Chapter B1, Low-Flow Investigations, Book 4, Hydrologic Analysis and Interpretation.

STATION NAME: 01BO001 SW MIRAMICHI RIVER AT BLACKVILLE

PERIOD OF RECORD: 1918 to 1933 USED 1918 to 1933
1961 to 1977 1961 to 1976

DRAINAGE AREA: 5051 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	33.228	35.415	36.869	39.470	47.463	62.606	75.619	101.188
2.0	19.799	19.792	20.577	22.124	24.722	30.334	38.650	50.106
5.0	14.571	14.665	15.246	16.336	17.990	20.901	26.568	34.083
10.0	12.447	12.825	13.334	14.233	15.747	17.788	22.245	28.516
20.0	11.048	11.721	12.191	12.959	14.474	16.033	19.656	25.256
50.0*	9.856	10.871	11.312	11.969	13.553	14.773	17.669	22.815
100.0*	9.268	10.495	10.923	11.526	13.171	14.253	16.791	21.763

*Unreliable due to Period of Extension

UNIT DISCHARGE (C.M.S./KM^2)

STATION NAME: 01BO001 SW MIRAMICHI RIVER AT BLACKVILLE

DRAINAGE AREA: 5051 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND/KM^2 x 10^{-3}							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	6.578	7.011	7.299	7.814	9.397	12.395	14.971	20.033
2.0	3.920	3.918	4.074	4.380	4.894	6.006	7.652	9.920
5.0	2.885	2.903	3.018	3.234	3.562	4.138	5.260	6.748
10.0	2.464	2.539	2.640	2.818	3.118	3.522	4.404	5.646
20.	2.187	2.321	2.414	2.566	2.866	3.174	3.892	5.000
50.0*	1.951	2.152	2.240	2.370	2.683	2.925	3.498	4.517
100.0*	1.835	2.078	2.163	2.282	2.608	2.822	3.324	4.309

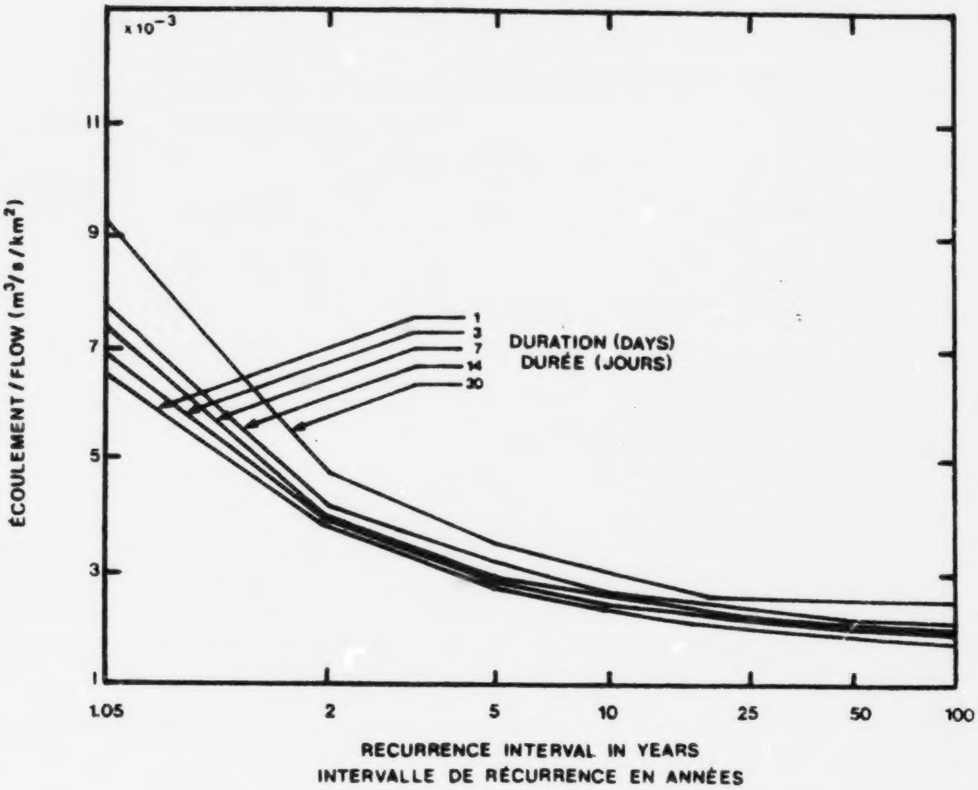
*Unreliable due to Period of Extension

1918–1933, 1961–1976

5051 km² TO GAUGE
A LA JAUGE

01B0001

SW MIRAMICHI RIVER AT BLACKVILLE
RIVIÈRE SW MIRAMICHI À BLACKVILLE



NEWCASTLE–CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE–CHATHAM
ETUDE DES RESSOURCES EN EAU

LOWFLOW FREQUENCY ANALYSIS

ANALYSE DE LA FRÉQUENCE DE FAIBLE ÉCOULEMENT

STATION NAME: 01BO002 RENOUS RIVER AT MCGRAW BROOK

PERIOD OF RECORD: 1965 TO Present USED 1965 to 1976

DRAINAGE AREA: 611 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	3.309	3.502	3.823	4.555	5.892	9.934	8.870	9.602
2.0	1.218	1.289	1.524	1.753	2.234	2.868	3.453	4.519
5.0	0.800	0.833	0.938	1.051	1.256	1.419	1.836	2.947
10.0	0.696	0.716	0.763	0.845	0.953	1.049	1.294	2.406
20.0	0.648	0.662	0.671	0.737	0.790	0.876	0.986	2.092
50.0*	0.620	0.630	0.610	0.667	0.679	0.776	0.761	1.858
100.0*	0.611	0.619	0.587	0.641	0.636	0.743	0.667	1.758

*Unreliable due to Period of Extension

UNIT DISCHARGE (C.M.S./KM^2)

STATION NAME: 01BO002 RENOUS RIVER AT MCGRAW BROOK

DRAINAGE AREA: 611 Km^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND/KM^2 x 10^{-3}							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	5.416	5.732	6.257	7.455	9.643	16.259	14.517	15.715
2.0	1.993	2.110	2.494	2.869	3.656	4.694	5.651	7.396
5.0	1.309	1.363	1.535	1.720	2.056	2.322	3.005	4.823
10.0	1.139	1.172	1.249	1.383	1.560	1.717	2.118	3.938
20.0	1.061	1.083	1.098	1.206	1.293	1.434	1.614	3.424
50.0*	1.015	1.031	0.998	1.092	1.111	1.270	1.245	3.041
100.0*	1.000	1.013	0.961	1.049	1.041	1.216	1.092	2.877

*Unreliable due to Period of Extension

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

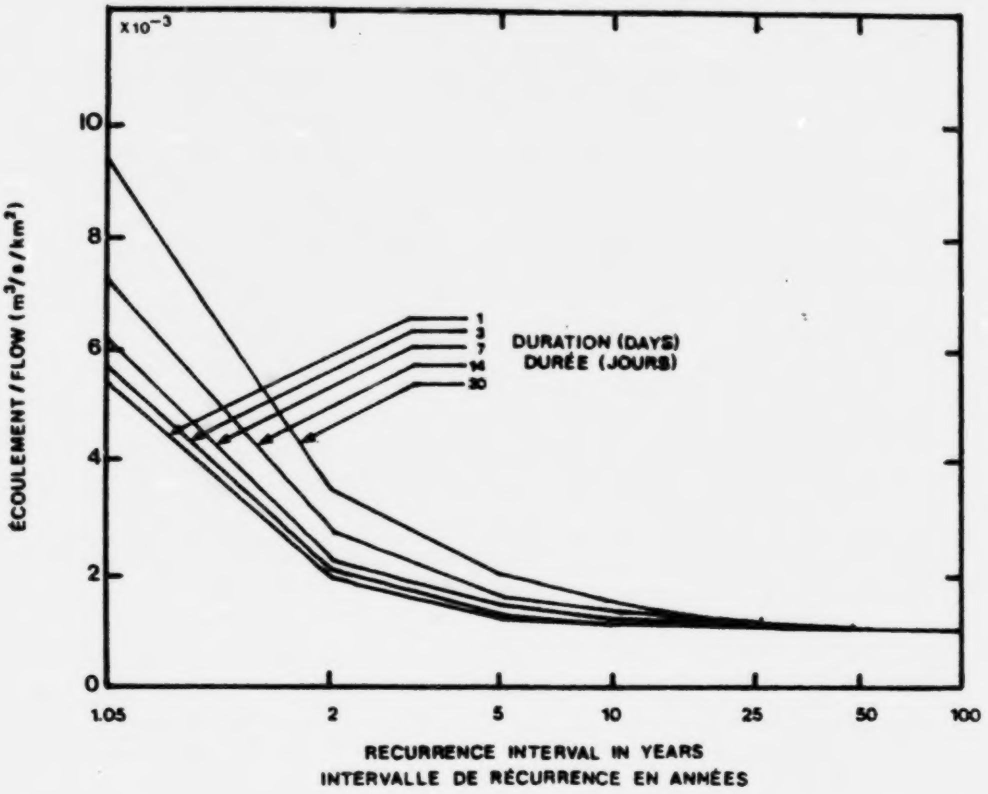
WATER RESOURCES BRANCH
DIRECTION DES RESSORCES EN EAU

1965 - 1976

611 km² TO GAUGE
A LA JAUGE

01BO002

RENOUS RIVER AT McGRAW BROOK
RIVIÈRE RENOUS À McGRAW BROOK



NEWCASTLE - CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE - CHATHAM
ETUDE DES RESSOURCES EN EAU

LOWFLOW FREQUENCY ANALYSIS

ANALYSE DE LA FRÉQUENCE DE FAIBLE ÉCOULEMENT

STATION NAME: 01BP001 LITTLE SW MIRAMICHI AT LYTTLETON

PERIOD OF RECORD: 1951 to PRESENT USED 1952 to 1976

DRAINAGE AREA: 1342 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	8.493	8.638	8.895	9.375	11.198	15.650	17.229	23.669
2.0	4.705	4.941	5.216	5.595	6.127	6.982	8.083	11.384
5.0	3.231	3.412	3.715	4.066	4.553	4.949	5.824	8.267
10.0	2.633	2.763	3.085	3.428	4.010	4.376	5.164	7.339
20.0	2.239	2.320	2.659	2.999	3.794	4.090	4.824	6.855
50.0	1.904	1.929	2.285	2.625	3.458	3.909	4.603	6.535
100.0*	1.739	1.729	2.096	2.437	3.358	3.844	4.521	6.414

*Unreliable due to Period of Extension

UNIT DISCHARGE (C.M.S./KM^2)

STATION NAME: 01BP001 LITTLE SW MIRAMICHI AT LYTTLETON

DRAINAGE AREA: 1342 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND/KM^2 x 10^{-3}							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	6.332	6.437	6.628	6.986	8.344	11.662	12.838	17.637
2.0	3.506	3.682	3.887	4.169	4.566	5.203	6.023	8.483
5.0	2.408	2.542	2.768	3.030	3.393	3.688	4.340	6.160
10.0	1.962	2.059	2.299	2.554	2.988	3.261	3.848	5.469
20.0	1.668	1.729	1.981	2.235	2.753	3.048	3.595	5.108
50.0	1.419	1.437	1.703	1.956	2.577	2.913	3.430	4.870
100.0*	1.296	1.288	1.562	1.816	2.502	2.864	3.369	4.779

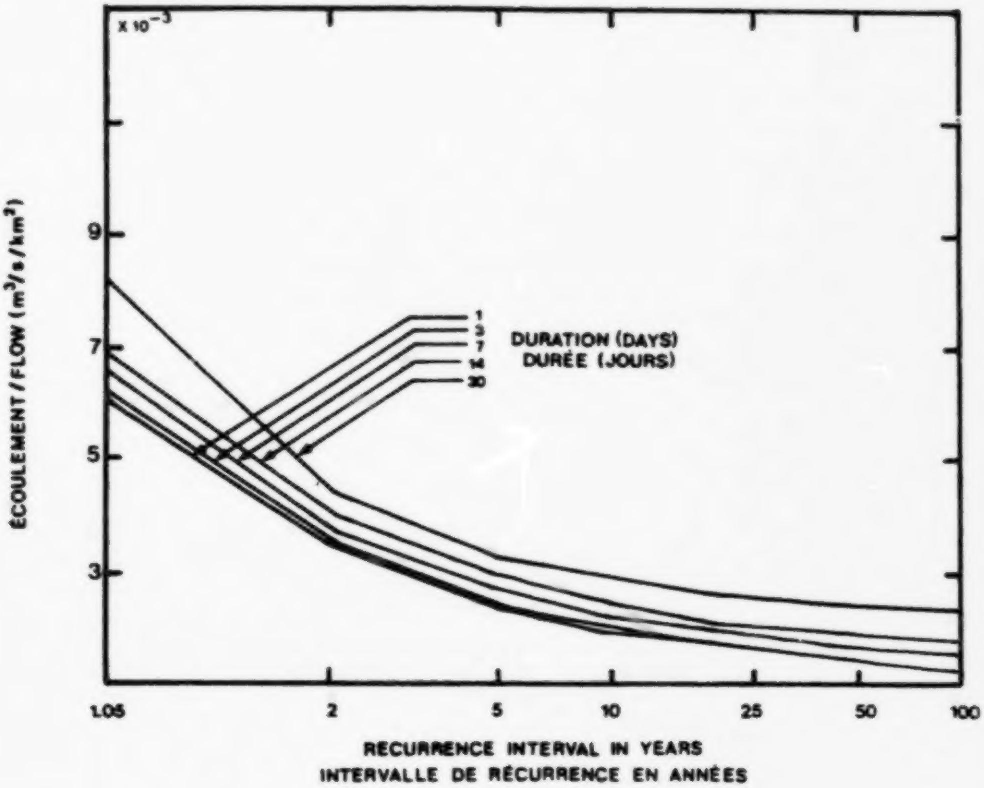
*Unreliable due to Period of Extension

OIBPOOI

1342 km² TO GAUGE
A LA JAUGE

1952-1976

LITTLE SW MIRAMICHI AT LYTTEETON
RIVIÈRE LITTLE SW MIRAMICHI À LYTTEETON



NEWCASTLE-CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE-CHATHAM
ETUDE DES RESSOURCES EN EAU

LOWFLOW FREQUENCY ANALYSIS

ANALYSE DE LA FRÉQUENCE DE FAIBLE ÉCOULEMENT

STATION NAME: 01BQ001 NW MIRAMICHI RIVER AT TROUT BROOK

PERIOD OF RECORD: 1961 to PRESENT USED 1961 to 1976

DRAINAGE AREA: 948 KM^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	5.832	5.959	6.319	6.888	9.360	11.559	10.888	15.851
2.0	2.965	3.064	3.168	3.370	3.664	4.399	5.261	7.036
5.0	2.385	2.437	2.507	2.670	2.894	3.171	3.920	4.982
10.0	2.239	2.270	2.335	2.496	2.748	2.895	3.538	4.407
20.0	2.171	2.190	2.254	2.416	2.694	2.779	3.345	4.120
50.0*	2.132	2.142	2.206	2.370	2.669	2.717	3.222	3.940
100.0*	2.119	2.125	2.190	2.355	2.663	2.699	3.177	3.875

*Unreliable due to Period of Extension

UNIT DISCHARGE (C.M.S./KM^2)

STATION NAME: 01BQ001 NW MIRAMICHI AT TROUT BROOK

DRAINAGE AREA: 948 Km^2

RETURN PERIOD IN YEARS	LOWFLOW IN CUBIC METRES PER SECOND/KM^2 x 10^{-3}							
	LOWFLOW PERIOD IN DAYS							
	1	3	7	14	30	60	90	120
1.050	6.152	6.286	6.666	7.266	9.873	12.193	11.485	16.720
2.0	3.128	3.232	3.342	3.555	3.865	4.640	5.550	7.422
5.0	2.516	2.571	2.645	2.816	3.053	3.345	4.135	5.255
10.0	2.362	2.395	2.463	2.633	2.899	3.054	3.732	4.649
20.0	2.290	2.310	2.378	2.549	2.842	2.931	3.528	4.346
50.0*	2.249	2.259	2.327	2.500	2.815	2.866	3.399	4.156
100.0*	2.235	2.242	2.310	2.484	2.809	2.847	3.351	4.088

*Unreliable due to Period of Extension

ENVIRONMENT N.B.
ENVIRONNEMENT N.-B.

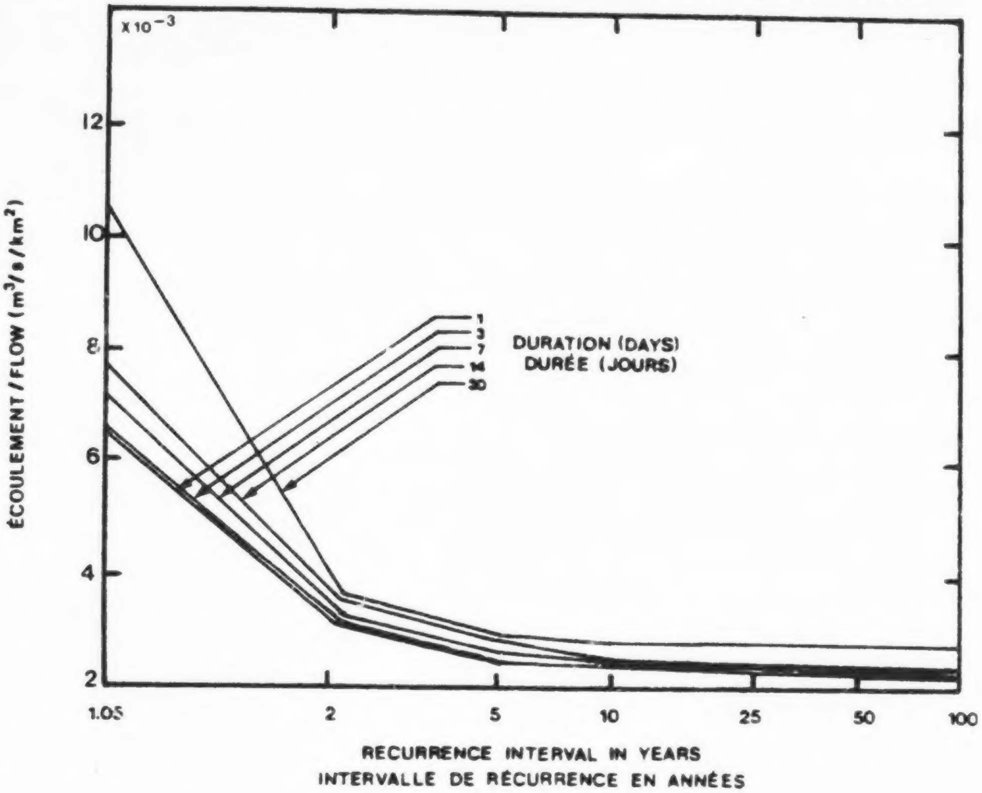
WATER RESOURCES BRANCH
DIRECTION DES RESSOURCES EN EAU

1961 - 1976

948 km² TO GAUGE
A LA JAUGE

01BQ001

NW MIRAMICHI AT TROUT BROOK
RIVIÈRE NW MIRAMICHI À TROUT BROOK



NEWCASTLE – CHATHAM PLANNING REGION
WATER RESOURCES REVIEW
REGION D'AMÉNAGEMENT DE NEWCASTLE – CHATHAM
ETUDE DES RESSOURCES EN EAU

LOWFLOW FREQUENCY ANALYSIS

ANALYSE DE LA FRÉQUENCE DE FAIBLE ÉCOULEMENT

APPENDIX G

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES IN THE FREDERICTON PLANNING REGION

TABLE (G.1)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1AH

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
BABBIT BROOK	9.2	13.0	3.7	4.7	.42	1.21
MILLER BROOK	4.5	12.1	4.0	5.3	.16	1.61
MCNAIR BROOK	20.5	23.6	9.2	8.8	.26	1.47
VANDINE BROOK	29.6	25.0	8.4	8.4	.42	1.30
WRIGHTS BROOK	13.0	21.8	9.9	9.3	.15	1.71
SALMON HOLE BROOK	12.4	18.3	6.3	6.1	.33	1.47
MCKEEN BROOK	16.4	17.1	7.1	5.2	.61	1.19
ANVIL BROOK	7.4	11.1	4.1	4.4	.38	1.15
L. HAND BRANCH BUBAR BK	25.3	22.8	7.1	6.4	.62	1.28
GIBERSON BROOK	7.0	12.5	4.2	4.8	.30	1.33
BUBAR BROOK	55.8	35.4	9.8	8.9	.70	1.34
GOLD BROOK	2.6	7.1	1.7	2.6	.38	1.24
FOUR MILE BROOK	29.1	29.4	11.9	11.4	.22	1.54
HAZELTON BROOK	21.4	25.2	8.5	6.7	.48	1.54
MCCARTY BROOK	5.0	9.0	1.2	3.4	.43	1.14
CLYDE BROOK	17.6	18.3	6.3	6.5	.42	1.23
SHANKS BROOK	5.4	11.8	3.3	3.8	.37	1.43
L. HAND BR. MAMOZEKEL R	42.9	33.7	12.8	10.5	.39	1.45
R. HAND BR. MAMOZEKEL R	58.1	34.9	17.1	10.9	.49	1.29
EVERETT BROOK	35.3	27.2	9.6	8.6	.48	1.29

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G. 2)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BK

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
INLET BROOK	21.8	26.3	11.1	9.5	1.59	.24
BROWN BROOK	7.1	12.1	3.1	5.1	1.28	.27
BIG BROOK	29.8	27.8	10.3	9.8	1.44	.31
LOWER E. BR. MOOSE BR.	9.7	15.6	6.4	6.3	1.41	.24
GARRETT BROOK	6.3	12.3	4.7	5.0	1.38	.25
MOOSE BROOK	58.7	42.7	16.0	14.0	1.57	.30
SEVENTY FIVE MILE BR.	24.3	26.5	8.3	8.0	1.52	.38
SILVER BROOK	31.4	28.5	11.9	9.4	1.43	.36
MERIDIAN BROOK	25.0	21.5	7.2	7.7	1.21	.42
MCLINTON BROOK	13.9	17.3	5.9	6.1	1.31	.37
LITTLE S.BR. NEPISIGUIT	80.4	52.4	20.1	16.2	1.65	.31
SIXTY-NINE MILE BROOK	25.3	23.1	7.1	6.3	1.30	.64
PENTLAND BROOK	23.4	24.1	7.5	6.9	1.41	.49
RANSOM BROOK	6.2	11.4	4.8	4.9	1.29	.26
LOWER W.BR. PORTAGE BK	24.9	27.9	9.9	9.2	1.58	.29
TOWER BROOK	6.6	11.9	5.3	4.6	1.31	.31
MEADOW BROOK	16.9	22.9	6.6	6.0	1.57	.47
PORTAGE BROOK	75.1	51.5	21.6	14.7	1.68	.35
LOWER S. NEPISIGUIT R.	25.8	24.1	9.1	8.5	1.34	.35
W.BRANCH S.NEPISIGUIT	83.6	52.8	24.4	16.0	1.63	.33
ADAMS BROOK	41.0	35.1	12.7	10.4	1.55	.38
SOUTH NEPISIGUIT R.	271.3	104.6	33.1	28.3	1.79	.34
WHITE BIRCH BROOK	5.9	12.1	3.8	4.9	1.41	.25
DEVILS ELBOW BROOK	22.7	22.5	8.6	8.1	1.33	.35
LITTLE ELBOW BROOK	8.9	17.4	7.2	5.1	1.65	.34
FIFTY MILE BROOK	4.5	9.0	3.3	3.5	1.28	.37
EAST MOODY BROOK	4.8	9.6	3.6	4.0	1.24	.30
MOODY BROOK	31.9	29.1	8.8	8.4	1.45	.45

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.1)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BK

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
GRANTS BROOK	14.9	23.3	4.4	4.7	1.70	.62
FRONSAC BROOK	16.8	20.9	6.5	6.0	1.44	.47
FLY TENT BROOK	9.5	13.4	5.0	4.5	1.23	.47
W. FORTY FOUR MILE BK	34.7	31.2	10.9	10.5	1.49	.31
HARTTS LAKE BROOK	12.4	15.9	7.7	5.4	1.27	.43
FORTY FOUR MILE BROOK	87.4	58.2	55.3	21.0	1.76	.20
SOUTH FORTY MILE BROOK	58.4	43.4	40.7	17.4	1.60	.19
FORTY MILE BROOK	220.2	83.0	38.0	20.9	1.58	.50
NEPISIGUIT RIVER	1594.2	268.4	74.6	67.8	1.90	.35

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.3)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1B1

Name of watercourse	Drain-age Area (sq.Km)	Basin Peri-meter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
W. BRANCH OYSTER R.	10.0	15.8	4.3	4.8	1.41	.43
E. BRANCH OYSTER R.	13.8	21.9	6.0	7.6	1.66	.24
OYSTER RIVER	35.6	32.4	9.6	9.1	1.53	.43
WHITES BROOK	7.9	10.6	3.7	3.8	1.06	.55
ROBICHAUD BROOK	5.9	10.0	2.4	3.9	1.16	.39
LYONS BROOK	19.4	18.9	9.0	7.6	1.21	.34
N. BURNT CHURCH RIVER	43.4	28.4	13.9	9.9	1.22	.44
S. BURNT CHURCH RIVER	41.6	29:7	12.6	9.5	1.30	.46
BIG BROOK	12.7	17.4	3.7	5.4	1.38	.44
ANDERSON BROOK	7.9	14.3	3.0	6.1	1.43	.21
BURNT CHURCH RIVER	133.2	56.4	27.0	19.8	1.37	.33
INDIAN BROOK	24.0	25.0	9.1	10.5	1.43	.21
RIVIERE DU CACHE	19.5	25.1	11.1	6.6	1.60	.45
MCKNIGHTS BROOK	25.0	26.8	7.9	7.9	1.51	.40
MALPEC BROOK	5.7	9.5	3.5	4.0	1.12	.35
N. TABUSINTAC RIVER	18.5	18.5	5.3	6.9	1.21	.38
MALIGET BROOK	18.7	20.7	8.5	8.2	1.35	.27
FORIENS BROOK	9.4	17.3	3.7	7.4	1.59	.17
LITTLE ESKEDELLOC R.	18.6	18.0	8.2	6.9	1.21	.39
BIG ESKEDELLOC RIVER	75.3	47.6	21.8	17.5	1.54	.24
MOOSE BROOK	2.8	7.3	1.7	2.0	1.23	.70
BIG BEAR BROOK	4.8	9.6	3.0	4.1	1.24	.29
NORTH BROOK	31.0	27.0	12.0	10.9	1.36	.26
MIDDLE BROOK	41.8	40.6	18.9	17.5	1.77	.13
PISIGUIT BROOK	43.2	37.5	18.6	16.2	1.60	.16
ROBINSON BROOK	4.3	8.1	2.1	2.4	1.10	.75
BIG HOLE BROOK	142.5	57.7	25.0	21.8	1.36	0.29
HIGH LANDING BROOK	1.8	5.9	2.0	2.5	1.24	.29

*F.F. ≡ Form Factor

#C.C. ≡ Compactness Coefficient

** 1:250,000 scale

Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.3)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BL

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
HAY LANDING BROOK	1.8	7.1	1.9	2.5	.29	1.49
TROUT BROOK	57.1	36.9	17.8	14.9	.96	1.37
BECKS BROOK	18.0	19.0	7.6	7.7	.30	1.26
DEEP PINE BROOK	6.1	12.1	2.4	5.4	.21	1.38
STILSON BROOK	10.4	18.1	5.7	7.2	.20	1.58
STYMIEST MILL BROOK	49.0	33.5	14.6	13.3	.28	1.35
BIG MARSH BROOK	8.0	11.3	3.8	3.8	.55	1.13
MCROBIE BROOK	2.3	7.1	1.9	3.2	.22	1.32
GASPEREAU BROOK	2.2	8.5	2.2	3.3	.20	1.62
COAL MINE BROOK	5.9	9.7	3.1	3.6	.46	1.13
LITTLE NORTH BROOK	12.9	17.2	6.3	6.1	.35	1.35
COWASSAGET STREAM	35.4	29.1	7.8	7.6	.61	1.38
STRAIGHT BROOK	2.2	7.2	1.4	3.2	.21	1.37
WEEKS BROOK	2.8	7.1	0.8	2.6	.41	1.20
MCLEODS BROOK	7.9	14.9	5.5	6.4	.19	1.50
FRENCH COVE BROOK	13.0	16.6	6.5	6.8	.28	1.30
LIMEKILN BROOK	0.8	4.3	1.0	2.0	.20	1.36
PALMERS BROOK	2.1	6.6	0.9	2.4	.36	1.34
TABUSINTAC RIVER	701.0	132.0	69.2	49.7	.28	1.40
FRASER BROOK	0.8	4.3	0.8	1.8	.25	1.36
ROBERTSON BROOK	3.8	8.9	1.4	3.5	.31	1.29
RUISSEAU A BRIDEAU	3.6	10.9	0.6	4.2	.20	1.62
RUIS A THIBODEAU	2.2	6.9	0.4	3.1	.23	1.31
PORTAGE CREEK	5.1	9.5	3.7	3.6	.39	1.19
MEADOW BROOK	8.9	13.5	5.8	4.4	.46	1.28
BURKES BROOK	1.6	5.5	0.5	2.3	.30	1.23
PORTAGE RIVER	51.8	34.3	11.4	10.8	.44	1.34

***F.F. ≡ Form Factor**
#C.C. ≡ Compactness Coefficient
**** 1:250,000 scale**
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.4)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BN

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
MODRE'S BROOK	28.7	31.6	14.0	15.6	.12	1.66
BERGINS BROOK	9.3	13.1	4.6	5.5	.31	1.21
S.E. BRANCH SIX MILE B	16.0	17.2	7.2	5.7	.49	1.21
EAST SIXMILE BROOK	53.0	39.6	18.5	13.6	.29	1.53
MUZROLL BROOK	181.8	71.9	37.2	30.6	.19	1.50
HICKEY BROOK	4.0	9.1	2.8	3.5	.33	1.28
FINN BROOK	5.2	12.3	3.4	4.3	.28	1.52
MEADOW BROOK	8.2	12.8	4.9	3.8	.57	1.21
SUTTON BROOK	8.2	14.3	5.6	4.9	.34	1.41
CHAIN MEADOW BROOK	14.4	16.2	5.9	5.9	.41	1.20
RYAN BROOK	11.9	17.4	7.4	6.8	.26	1.42
EAST SABBIES RIVER	60.0	51.1	24.1	18.3	.18	1.86
WEST SABBIES RIVER	98.2	49.5	23.7	15.3	.42	1.41
SABBIES RIVER	223.6	77.2	26.9	16.6	.81	1.46
PICKARD BROOK	23.1	25.6	9.4	9.7	.25	1.50
SOUTH BR. SALMON BROOK	7.8	10.5	3.4	3.3	.72	1.06
SALMON BROOK	62.2	40.6	14.8	15.2	.27	1.45
BUTTER MILK BROOK	5.6	10.1	2.2	4.1	.33	1.20
COLD BROOK	6.5	11.7	3.2	5.0	.26	1.29
HALFWAY SPRING BROOK	5.2	12.3	3.0	5.2	.20	1.52
LITTLE OTTER BROOK	11.1	16.0	5.9	6.5	.26	1.35
OTTER BROOK	68.2	47.2	20.4	12.6	.43	1.61
CAINS RIVER	1533.4	232.5	109.4	73.3	.29	1.67
NORTH BR. BLACK BROOK	5.0	8.6	2.3	2.5	.80	1.08
SOUTH BR. BLACK BROOK	13.1	13.6	4.5	4.4	.68	1.06
TOMBLAY BROOK	6.4	9.8	3.0	3.5	.52	1.09
BLACK BROOK	83.1	48.6	20.9	15.5	.35	1.50

***F.F. ≡ Form Factor**
#C.C. ≡ Compactness Coefficient
**** 1:250,000 scale**
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.5)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BO

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
MCKENZIE BROOK	26.0	23.2	10.0	9.3	.30	1.28
ZACKS BROOK	7.6	11.1	2.8	4.5	.38	1.14
MORSE BROOK	38.3	38.0	16.9	16.0	.15	1.73
MERSEREAUS BROOK	9.1	12.5	4.3	5.2	.34	1.17
BECKET BROOK	14.0	19.2	7.3	8.2	.21	1.45
NORTH BARTHOLOMEW R.	40.9	35.0	14.5	14.0	.21	1.54
SOUTH BARTHOLOMEW R.	32.8	33.0	18.0	13.2	.19	1.63
MUD BROOK	7.8	13.0	4.0	5.2	.29	1.31
DAVIS LANDING BROOK	23.5	21.0	8.5	9.5	.26	1.22
BEAVER BROOK	11.8	13.2	3.9	4.1	.70	1.08
FOUR MILE BROOK	13.1	15.3	7.7	4.0	.82	1.19
FOWLER MEADOW BROOK	9.1	13.4	5.9	6.1	.24	1.25
LEDBETTERS BROOK	47.6	32.5	12.0	12.4	.31	1.33
LITTLE MCGRAW BROOK	5.7	11.3	4.5	4.4	.29	1.34
WILDCAT BROOK	5.8	10.7	3.1	3.8	.40	1.25
MCLAGGAN BROOK	4.3	10.4	3.5	4.0	.27	1.41
GRINDSTONE BROOK	0.4	3.1	0.8	1.4	.20	1.38
WALSH BROOK	10.3	15.3	4.1	5.6	.33	1.34
OTTER BROOK	32.5	31.8	15.1	10.2	.31	1.57
WATSON BROOK	3.8	9.1	2.9	3.3	.35	1.32
BARTHOLOMEW RIVER	380.8	132.5	62.5	54.0	.13	1.92
GRAY RAPIDS BROOK	14.8	16.2	4.6	4.6	.70	1.19
RESERVE BROOK	4.5	10.2	3.1	4.4	.23	1.36
CURTIS BROOK	1.8	6.7	1.3	3.1	.19	1.41
WHITE RAPIDS BROOK	19.0	28.1	12.3	11.6	.14	1.82
MORRISON BROOK	11.6	19.9	4.9	6.2	.30	1.65
MCKENDRICK BROOK	14.1	21.0	3.9	7.0	.29	1.58
MORAN BROOK	4.1	11.0	3.8	4.6	.19	1.53

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.5)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1B0

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
LAKE BROOK	29.4	37.2	14.9	12.8	.18	1.94
LITTLE OTTAWA BROOK	62.0	37.0	15.0	12.7	.38	1.33
UPPER MCGRAW BROOK	12.9	18.8	7.2	6.8	.28	1.48
QUIGLEY BROOK	6.7	12.6	4.2	5.2	.25	1.37
ROCKY BROOK	11.6	21.3	7.4	8.8	.15	1.76
ORCHARD BROOK	8.4	12.6	4.2	3.7	.61	1.23
NORTH RENOUS RIVER	295.3	107.5	52.5	44.3	.15	1.76
LITTLE S. RENOUS RIVER	50.4	36.7	16.7	12.8	.31	1.46
WHITESTONE BROOK	6.9	11.5	5.9	4.8	.30	1.24
DAY BROOK	20.8	26.1	10.8	10.5	.19	1.61
LITTLE DAY BROOK	6.7	10.4	3.0	3.1	.70	1.13
MEADOW BROOK	19.4	19.5	7.3	6.3	.49	1.25
SOUTH MONAGHAN BROOK	11.1	16.4	6.5	7.2	.21	1.39
NORTH BROOK MONAGHAN BR	21.4	22.3	8.6	7.2	.41	1.36
JACK O'BRIEN BROOK	4.6	9.8	3.3	3.9	.47	1.29
MONAGHAN BROOK	49.8	33.0	14.5	12.8	.30	1.32
SOUTH RENOUS RIVER	316.4	105.0	52.5	34.0	.27	1.66
MCGRAW BROOK	18.3	24.4	9.5	9.2	.22	1.61
SHIELDS BROOK	11.4	21.5	3.0	9.2	.13	1.80
DEVILS BACK BROOK	9.1	13.0	3.2	4.0	.57	1.22
NICHOLSON BROOK	16.9	25.3	6.9	11.0	.14	1.74
CROWN POINT BROOK	23.0	27.2	11.4	10.5	.21	1.60
JOHNSTONE BROOK	5.7	11.8	5.9	4.5	.28	1.39
MILL BROOK	5.5	13.2	5.7	6.0	.15	1.59
NORTH DUNGARVON RIVER	26.8	28.6	9.1	8.5	.37	1.56
SOUTH DUNGARVON RIVER	15.3	21.0	7.8	7.4	.28	1.51
TWIN LAKES BROOK	11.6	18.1	5.6	5.8	.34	1.50
FALL BROOK	11.0	18.6	7.5	6.1	.30	1.58

***F.F. ≡ Form Factor**
#C.C. ≡ Compactness Coefficient
**** 1:250,000 scale**
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.5)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1B0

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
MCCONNELL BROOK	19.9	21.7	5.9	6.8	.46	1.37
UNDERWOOD BROOK	20.7	24.0	10.1	9.2	.24	1.49
JARDINE BROOK	7.6	13.8	6.5	4.8	.33	1.41
GOOSEBERRY MEADOW BROOK	6.0	11.4	5.1	4.9	.25	1.31
DUNGARVON RIVER	572.6	190.0	82.5	66.0	.13	2.24
RESERVE BROOK	22.7	24.6	11.1	8.1	.35	1.46
PINE ISLAND BROOK	9.5	13.5	3.2	5.9	.27	1.24
BUTTYS BROOK	4.4	11.1	2.9	2.9	.52	1.49
RENOUS RIVER	1427.1	212.5	80.5	72.0	.28	1.59
HELLCAT BROOK	3.9	8.5	1.3	3.5	.32	1.21
NORTH BR INDIANTOWN BR.	8.9	12.1	4.3	4.1	.53	1.14
LAKE BROOK	12.6	15.5	6.3	6.2	.33	1.23
WEST BR INDIANTOWN BR.	15.2	20.1	9.5	8.3	.22	1.45
INDIANTOWN BROOK	73.7	37.1	9.8	9.6	.80	1.22
HACKETT BROOK	6.4	10.5	2.3	3.6	.49	1.17
ELMTREE BROOK	6.6	13.9	2.8	4.1	.39	1.53
DOYLES BROOK	24.5	25.1	10.8	9.2	.29	1.43
WILSON BROOK	5.1	9.3	2.3	3.6	.39	1.16
CUSHMAN BROOK	4.3	10.4	4.6	3.3	.39	1.41
MEADOW BROOK	18.6	17.4	4.7	5.3	.66	1.14
EAST BARNABY RIVER	11.3	14.1	5.0	5.0	.45	1.18
MIDDLE BARNABY RIVER	63.1	45.3	19.8	15.7	.26	1.61
BALDWINS BROOK	6.5	11.5	4.2	4.0	.41	1.27
WISEMAN BROOK	3.1	7.7	1.6	3.2	.30	1.23
LITTLE SEMIWAGON BROOK	20.8	19.0	6.6	6.8	.45	1.18
JAM BROOK	9.4	16.0	4.6	6.8	.20	1.47
RIGHT HAND BR BARNABY R	104.6	60.8	26.6	21.7	.22	1.68

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.5)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1B0

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
APPLEBY BROOK	16.4	19.7	4.0	6.2	.42	1.37
SEMIWAGEN RIVER	73.2	57.1	24.5	21.3	.16	1.88
SAUNDERS BROOK	16.7	10.8	3.2	4.4	.86	0.74
BARNABY RIVER	493.6	111.0	48.3	29.5	.56	1.40
SOUTHWEST MIRAMICHI R	6563.0	544.8	208.5	128.5	.40	1.90
SUTHERLAND BROOK	23.9	24.3	9.7	9.6	.25	1.40
GILLEN BROOK	15.4	17.3	4.1	7.0	.31	1.24
BEAVER BROOK	10.1	13.9	4.4	4.8	.44	1.15
HIGHBANK BROOK	9.3	14.7	4.2	5.3	.33	1.36
JOHN BROOK	13.4	16.8	6.0	6.5	.32	1.29
OX BROOK	15.0	17.3	8.5	7.6	.26	1.26
COW BROOK	26.5	22.3	9.6	9.3	.31	1.22
LITTLE MILLSTREAM	18.3	20.0	6.2	6.2	.48	1.32
NORTHWEST MILLSTREAM	196.8	70.4	40.0	19.7	.51	1.42
MCKAY BROOK	14.0	19.5	7.3	8.5	.19	1.47
OXFORD BROOK	18.2	21.5	7.1	9.1	.22	1.42
NORTHWEST MIRAMICHI R	2509.8	286.0	122.3	79.2	.40	1.61
CARDING MILL BROOK	11.4	14.7	5.3	5.0	.46	1.23
MEADOW BROOK	3.9	9.9	2.2	3.9	.25	1.41
FRENCH FORT BROOK	19.6	19.5	7.6	6.4	.47	1.24
HUTCHINSON BROOK	3.7	10.5	3.2	4.1	.22	1.53
MCKENOY BROOK	1.9	9.0	1.0	4.1	.11	1.84
MCEWEN BROOK	2.0	8.6	1.6	4.1	.11	1.71
MILL COVE BROOK	8.5	12.4	12.5	13.0	.05	1.19
BIG BROOK	3.0	7.7	2.5	3.0	.33	1.25
BLACK BROOK	7.3	12.2	5.0	5.2	.27	1.27
SOUTH BARTIBOG RIVER	4.8	8.3	2.7	3.0	.53	1.07
MIDDLE BARTIBOG RIVER	34.0	30.0	9.2	10.7	.29	1.45

***F.F. ≡ Form Factor**
#C.C. ≡ Compactness Coefficient
**** 1:250,000 scale**
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.5)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1B0

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
CAMPBELL BROOK	12.3	14.5	6.2	5.6	.39	1.17
NORTH BARTIBOG RIVER	30.3	25.1	10.2	10.1	.30	1.29
GOODFELLOWS BROOK	27.1	24.2	6.2	7.1	.54	1.31
WILDCAT BROOK	18.1	24.2	10.5	10.2	.17	1.60
GREYSTONE BROOK	6.2	13.3	4.8	5.0	.25	1.51
DOYLES BROOK	4.9	12.2	2.7	4.4	.25	1.55
MOSQUITO BROOK	10.7	13.5	4.1	4.9	.45	1.16
CRAZY BROOK	6.0	10.5	4.5	4.3	.32	1.21
LOWER GREEN BROOK	8.5	13.4	3.8	4.7	.38	1.30
YOUNGS BROOK	19.1	25.3	8.8	10.1	.19	1.63
MCDONALD BROOK	2.2	7.2	1.5	3.0	.24	1.37
GREEN BROOK	122.2	57.0	30.5	20.6	.29	1.45
BEAR BROOK	5.5	11.1	4.9	4.7	.25	1.34
SOUTH LITTLE BARTIBOG R	25.9	28.4	8.7	10.6	.23	1.57
JUNIPER BROOK	13.3	15.2	5.1	5.2	.49	1.18
NORTH LITTLE BARTIBOG R	41.3	32.0	11.4	9.7	.44	1.40
COLTARTS BROOK	23.0	19.9	8.7	5.3	.82	1.17
MILL BROOK	3.5	8.5	2.3	3.8	.24	1.28
LITTLE BARTIBOG RIVER	108.2	49.3	18.6	15.6	.44	1.34
BARTIBOG RIVER	522.9	108.1	61.0	31.5	.53	1.33
MURDOCH BROOK	4.5	8.5	3.3	3.4	.39	1.13
MIRAMICHI RIVER	12302.7	736.8	267.3	168.3	.43	1.87

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.6)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BP

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
POTHOLE BROOK	5.6	12.5	3.2	4.4	.28	1.49
MIDDLE BROOK	2.8	10.4	2.2	4.6	.13	1.75
PATCHELL BROOK	42.9	36.4	8.0	9.8	.44	1.56
CARIBOU BROOK	9.3	12.8	7.1	5.2	.34	1.18
N.W.BR.LITTLE S.W. - MIRAMICHI R.	59.9	42.0	18.6	17.3	.20	1.53
TUADOOK RIVER	175.8	84.0	31.9	22.1	.35	1.78
INDIAN BROOK	6.7	13.4	5.3	5.7	.20	1.46
E.BR.NORTH POLE BROOK	13.6	15.8	3.9	4.2	.77	1.20
W.BR. NORTH POLE BROOK	10.2	14.8	6.9	5.9	.29	1.30
CAVE BROOK	26.4	25.2	9.6	6.9	.55	1.39
LIZARD BROOK	14.1	22.2	9.0	6.9	.29	1.66
SINCLAIR BROOK	13.5	17.4	5.5	5.2	.49	1.33
KILLHEG BROOK	6.3	11.3	3.5	3.5	.51	1.27
NORTH POLE BROOK	212.9	95.1	36.9	31.5	.21	1.84
MAINS BROOK	24.3	24.7	10.2	7.5	.43	1.41
FATHER MURDOCH BROOK	5.2	11.6	3.6	4.1	.30	1.43
UPPER LIBBIES BROOK	16.3	21.9	9.2	8.6	.22	1.53
PORCUPINE BROOK	3.8	8.3	2.4	3.4	.32	1.20
LOWER LIBBIES BROOK	9.0	13.7	3.3	3.6	.69	1.28
LIBBIES BROOK	35.6	34.0	11.9	9.6	.38	1.61
MALCOLM BROOK	10.6	17.5	7.3	7.9	.16	1.52
GUAGUS STREAM	69.1	53.7	20.9	19.0	.19	1.82
LOWER N.BR. L.S.W. - MIRAMICHI R.	213.2	105.7	41.1	40.3	.13	2.04
SHORE CAMP BROOK	25.0	24.9	10.9	7.2	.48	1.40
DEVILS BROOK	33.2	31.3	11.6	11.7	.24	1.53
PARKS BROOK	22.0	24.0	7.8	7.8	.36	1.44

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G. 6)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BP

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
SUTHERLAND BROOK	2.7	7.8	1.7	3.2	.26	1.34
CATAMARAN BROOK	51.3	42.4	19.8	17.9	.16	1.67
REDSTONE BROOK	6.8	15.2	5.2	5.2	.25	1.64
OTTER BROOK	13.4	20.0	4.4	6.3	.34	1.54
HARRIS BROOK	18.0	19.9	7.2	6.5	.43	1.32
MCKENZIE BROOK	1.7	5.4	1.0	2.1	.39	1.17
LITTLE S.W.MIRAMICHI R	1309.3	282.0	110.3	78.8	.21	2.20

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.7)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BQ

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
S.BRANCH N.W.MIRAMICHI	50.8	35.7	13.9	10.4	.46	1.41
FORTY TWO BROOK	8.6	14.8	5.0	3.9	.56	1.42
FLAHERTY BROOK	4.3	8.6	2.4	2.5	.68	1.16
MOOSE BROOK	4.5	10.0	3.5	3.3	.41	1.32
MOUNTAIN BROOK	27.2	25.8	9.5	9.2	.32	1.39
STONY BROOK	26.4	27.8	11.0	9.9	.26	1.52
TOZER BROOK	5.6	11.7	4.4	4.7	.25	1.39
LITTLE RIVER	91.0	75.4	33.7	24.2	.15	2.22
SPRIG BROOK	6.5	11.6	5.1	3.9	.42	1.28
LITTLE S.TOMOGONOPS R	28.0	33.1	16.7	12.8	.17	1.76
LAKE BROOK	12.5	19.0	7.8	7.4	.22	1.51
N.BRANCH TOMOGONOPS R.	46.3	51.7	19.6	18.3	.13	2.14
SANDBURN BROOK	12.9	16.4	6.8	6.5	.30	1.28
S.BRANCH TOMOGONOPS R.	45.4	38.3	15.6	14.5	.21	1.60
TOMOGONOPS RIVER	160.2	74.5	28.3	24.9	.25	1.66
MCKAY BROOK	10.9	12.9	5.0	4.7	.49	1.10
TOZER BROOK	20.5	23.0	10.6	9.4	.23	1.43
EAST PORTAGE RIVER	91.8	43.0	17.4	15.9	.36	1.26
PORTAGE RIVER	180.8	75.7	22.2	19.1	.49	1.58
SMOKER BROOK	28.8	23.6	10.3	9.1	.34	1.24
MCLAUGHLIN BROOK	11.9	22.1	7.2	8.8	.15	1.80
PATS BROOK	9.6	14.1	4.5	6.1	.25	1.28
TWO MILE BROOK	15.0	17.5	6.0	7.2	.28	1.27
LEE BROOK	25.6	27.3	11.0	11.5	.19	1.52
COPPS BROOK	14.3	19.1	8.8	7.3	.26	1.42
TROUT BROOK	45.3	35.5	17.4	14.9	.20	1.48
BILLS BROOK	2.9	7.3	2.1	2.3	.54	1.20
LITTLE N.SEVOGLE RIVER	21.1	21.3	9.2	8.5	.29	1.30

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.7)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1PQ

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
LAKE BROOK	17.4	20.1	8.1	7.4	.31	1.36
CAMP DORIS BROOK	4.1	9.4	3.4	4.0	.25	1.31
NORTH SEVEGLE RIVER	205.1	109.8	53.9	39.6	.13	2.16
LITTLE S.SEVOGLE RIVER	24.0	25.5	11.1	10.2	.23	1.47
BARRACKS BROOK	15.4	21.3	8.9	6.6	.35	1.53
N.BRANCH S.SEVOGLE R.	39.5	35.3	16.1	14.2	.19	1.58
TRAVIS BROOK	17.8	18.2	5.3	7.0	.36	1.22
CLEARWATER STREAM	60.0	49.0	22.0	17.9	.19	1.78
HUBBARD BROOK	8.9	15.7	6.0	6.4	.22	1.48
SHEEPHOUSE BROOK	33.3	50.8	25.0	20.6	.08	2.48
LITTLE SHEEPHOUSE BROOK	25.8	27.7	12.6	11.8	.19	1.54
NORTH MULLIN STREAM	29.5	24.2	12.6	8.6	.40	1.27
MULLIN STREAM	163.9	82.4	41.9	29.6	.19	1.79
STAIRS BROOK	13.3	18.9	5.8	8.1	.20	1.46
SOUTH SEVOGLE RIVER	522.2	118.9	52.2	37.8	.37	1.47
TINGLEY BROOK	7.1	13.9	5.3	6.2	.18	1.47
WHITNEY BROOK	27.3	35.7	12.0	14.8	.12	1.93
SEVOGLE RIVER	793.2	145.4	66.8	49.0	.33	1.46
S.BRANCH LITTLE SEVOGLE	33.2	30.5	14.6	13.0	.20	1.49
MCNEAL BROOK	31.7	34.0	15.1	15.7	.13	1.70
GILLICE BROOK	8.3	14.9	6.8	6.1	.22	1.46
BIG BROOK	19.0	23.6	7.1	8.4	.27	1.53
LITTLE SEVOGLE RIVER	111.6	65.8	33.5	27.0	.16	1.76
MILE BROOK	5.0	9.4	3.0	3.9	.33	1.19
LITTLE WILDCAT BROOK	3.5	8.0	1.4	3.2	.34	1.21
WILDCAT BROOK	46.2	34.0	6.8	10.3	.44	1.41
LITTLE CASTOR BROOK	2.8	7.0	2.4	3.0	.31	1.18
CASTOR BROOK	36.9	29.9	14.4	12.1	.25	1.39

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.8)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION 1BR

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
NORTHWEST NAPAN RIVER	15.8	19.5	5.1	7.9	.25	1.38
GALLOWS BROOK	8.1	17.0	7.1	7.5	.14	1.69
NAPAN RIVER	113.8	54.1	26.9	20.8	.26	1.43
TAYLOR CREEK	5.9	10.3	2.6	3.7	.43	1.20
LAKE BROOK	10.2	13.8	5.1	5.1	.39	1.22
VANDY BROOK	12.5	15.7	4.1	6.0	.35	1.25
GOODFELLOW BROOK	29.3	22.6	4.6	7.9	.47	1.18
MCBEATH BROOK	14.1	17.6	4.9	6.4	.34	1.32
BIG BROOK	9.8	12.4	5.0	4.6	.46	1.12
WELLS BROOK	24.2	23.4	10.7	10.1	.24	1.34
LITTLE BLACK RIVER	75.4	44.2	17.8	14.8	.51	1.44
WELLS BROOK	10.5	15.7	3.5	6.7	.23	1.37
BLACK RIVER	278.6	77.8	35.2	24.8	.45	1.31
W.BRANCH HORTONS CREEK	12.8	16.8	5.8	6.3	.32	1.32
E BRANCH HORTONS CREEK	8.9	12.6	3.1	5.0	.36	1.19
HORTONS CREEK	26.7	21.7	9.5	9.3	.31	1.18
E.BR.BAY DUVIN RIVER	17.7	17.5	7.8	6.6	.41	1.17
BIG HOVRL BROOK	14.6	15.6	6.8	6.9	.31	1.15
PEABODY BROOK	15.2	16.8	8.2	7.1	.30	1.22
ETTRICK BROOK	31.2	25.6	12.1	10.1	.31	1.29
TWO MILE BROOK	10.7	12.2	4.5	3.8	.74	1.05
ROBICHAUD CREEK	6.7	10.6	3.2	3.3	.62	1.15
** BAY DU VIN RIVER	289.1	104.5	53.4	39.8	.18	1.73
DENNISON CREEK	14.8	15.0	5.7	5.4	.51	1.10
FRENCH RIVER	8.5	12.0	4.7	5.0	.34	1.16
E. BRANCH EEL RIVER	23.1	23.6	10.2	6.7	.51	1.39
W. BRANCH EEL RIVER	15.6	16.7	6.2	6.7	.35	1.19
NADEAU CREEK	6.3	13.7	4.4	6.3	.16	1.54

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.

TABLE (G.8)

PHYSICAL DESCRIPTION OF SELECTED WATERCOURSES

DRAINAGE INDEX SUBDIVISION IBR

Name of watercourse	Drainage Area (sq.Km)	Basin Perimeter (Km)	Meander Length (Km)	Basin Length (Km)	Basin Shape	
					F.F.*	C.C.#
MEADOW BROOK	13.9	16.3	5.0	6.4	.33	1.23
E. BRANCH PORTAGE RIVER	14.8	14.1	4.6	5.2	.54	1.03
PORTAGE RIVER	73.7	40.9	20.0	15.3	.31	1.34
EEL RIVER	47.3	29.2	12.5	10.7	.41	1.19

*F.F. ≡ Form Factor
#C.C. ≡ Compactness Coefficient
** 1:250,000 scale
Coversion Factor: 1 mile = 1.609 Km.